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INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

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Established by Convention between Canada, Japan and the United States for the Conservation of the Fisheries Resources of the North Pacific Ocean

ANNUAL REPORT

FOR THE YEAR

1959

VANCOUVER, CANADA

1960

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

MEMBERS - 1959

CANADA

George R. Clark
John M. Buchanan
James C. Cameron
Roger T. Hager

UNITED STATES

Milton E. Brooding
Edward W. Allen
John H. Clawson
Arnie J. Suomela

JAPAN

Iwao Fujita
Haruki Mori
Kenjiro Nishimura
Kyuhei Suzuki (to Feb. 17, 1959)
Koichiro Kobayashi (from Feb. 17, 1959)

SECRETARIAT

Roy I. Jackson, Executive Director
Hiroshi Kasahara, Assistant Director

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Established by Convention between Canada, Japan and the United States for the Conservation of the Fisheries Resources of the North Pacific Ocean

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ANNUAL REPORT

FOR THE YEAR

1959

OFFICES

6640 N.W. Marine Drive
Vancouver 8, B.C.

LETTER OF TRANSMITTAL

The Chairman of the International North Pacific Fisheries Commission presents his compliments to the Contracting Parties and their Commissioners and has the honour to transmit herewith an Annual Report describing the activities of the Commission during the year terminating with the end of the Sixth Annual Meeting on November 7, 1959.

The Report is presented in compliance with Article III (1) (f) of the International Convention for the High Seas Fisheries of the North Pacific Ocean and Rule 14 (f) of the Rules of Procedure.

EDWARD W. ALLEN,
Chairman.

FOREWORD

This is the sixth annual report of the International North Pacific Fisheries Commission, established by a Convention between Canada, Japan and the United States which came into effect on June 12, 1953. In 1959, research projects, established under the Commission's program, continued to concentrate on the exceedingly complex questions of distribution and continental origin of salmon on the high seas.

As in the past, the investigations required by the Commission have been executed by fisheries agencies of the three Contracting Parties, acting under the Commission's program and coordination. Summaries of the results of research, prepared by these research agencies, are included in this annual report. The views in these summaries are those of the authors and not necessarily those of the Commission.

In 1959 the Commission again studied the stocks of salmon, halibut and herring in the eastern North Pacific to determine whether or not these stocks continued to meet the abstention qualifications stated in the Convention, or if changes should be recommended. No recommendations for changes in abstention with respect to salmon or halibut stocks were made at this annual meeting. However, the Commission determined that the herring stocks off the coast of Alaska south of the Alaskan Peninsula and east of the meridian passing through the extremity of the Alaskan Peninsula, no longer meet the qualifications for abstention. The Commission has therefore recommended to the Contracting Parties that these herring stocks be removed from abstention by appropriate amendment of the Annex to the Convention.

The Commission took action with respect to its inability to agree on an interpretation of the intent of the Protocol to the Convention by asking the Governments of Canada, Japan and the United States to provide it with an agreed interpretation.

The Commission took a number of positive steps toward expediting the collation and publication of the results of its research program. The tremendous amount of information collected in the Convention area will provide invaluable reference material in the years to come. The Commission has also decided to publish all the materials it has accumulated in connection with the abstention determinations on the salmon, halibut and herring stocks in the eastern North Pacific. The scientific reports dealing with the herring stocks have been approved for immediate release and for publication as soon as possible.

Studies of the king crab population of the eastern Bering Sea were continued by scientists of Japan and the United States, acting in accordance with a request made in 1954 by the United States under the provisions of Article III (1) (c) (i) of the Convention. These studies have not indicated, to date, that specific recommendations for joint conservation measures with respect to the existing fishery need be made.

The Commission is working diligently and carefully to find mutually agreeable solutions to extraordinarily difficult problems. Progress is substantial and knowledge and understanding continue to increase.

ROY I. JACKSON,
Executive Director.

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I. REPORT OF THE SIXTH ANNUAL MEETING 1959

of the

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Seattle, Washington, November 2 to 7, 1959

1. TIME AND PLACE OF MEETING

The Sixth Annual Meeting of the International North Pacific Fisheries Commission was held at the Benjamin Franklin Hotel in Seattle, Washington, from November 2nd to 7th, 1959. The Chairman of the meeting was Mr. Edward W. Allen of the United States.

Meetings of various committees established by the Commission were held prior to and at intervals between the plenary sessions. These included the following: a meeting of a scientific sub-committee of the Ad Hoc Committee on Abstention, which was held at the Commission's headquarters in Vancouver, British Columbia, October 12th to 17th, under rotating chairmanship. Sessions of the Standing Committee on Biology and Research began on October 19th under the chairmanship of Mr. Koichiro Kobayashi of Japan. The Ad Hoc Committee on Abstention began its sessions on October 27th under the chairmanship of Mr. George R. Clark of Canada. Mr. Clark was also Chairman of the Ad Hoc Committee on the Protocol which met first on October 29th. The Standing Committee on Finance and Administration began its work on October 31st with Mr. Roger T. Hager of Canada as Chairman.

All committee sessions, with the exception of the meetings of the sub-committee of the Ad Hoc Committee on Abstention, were also held at the Benjamin Franklin Hotel in Seattle.

2. PARTICIPANTS

A list of the officers and members of the Commission and all of its committees and the names of all accredited participants in the Sixth Annual Meeting are given in Appendix I of this report.

The Canadian delegation, consisting of 23 persons, was headed by Commissioner George R. Clark and included Commissioners John M. Buchanan, James C. Cameron, Roger T. Hager and 19 experts and advisors.

The Japanese delegation was headed by Commissioner Iwao Fujita, who was accompanied by Commissioners Kenjiro Nishimura and Koichiro Kobayashi. Fourteen experts and advisors brought the total Japanese delegation to 17 persons.

The United States delegation was headed by Commissioner Milton E. Brooding who was accompanied by Commissioners Edward W. Allen, John H. Clawson and Arnie J. Suomela. Fifty-five experts, advisors and members of its Advisory Committee brought the total United States delegation to 59 persons.

At the invitation of the Commission, one or more official observers were present from the Food and Agriculture Organization of the United Nations, the International Pacific Halibut Commission, the International Pacific Salmon Fisheries Commission, the International Commission for the Northwest Atlantic Fisheries and the Union of Soviet Socialist Republics; bringing the total number of accredited participants to 114. Eleven permanent and temporary members of the Secretariat assisted in the conduct of the meeting.

3. THE AGENDA

The Commission adopted, without change, the provisional agenda which had previously been circulated sixty days in advance of the meeting, as required by the Rules of Procedure. The agenda, as adopted, constitutes Appendix II of this report.

For the convenience of the reader, the text of International Convention for the High Seas Fisheries of the North Pacific Ocean is also attached to this report, forming Appendix III.

4. OPENING SESSION

The first plenary session of the Sixth Annual Meeting was held in Seattle on November 2nd. Under a standing Commission decision, members of the public and press were invited to attend the session. The Honourable Hugh J. Wade, Secretary of State, State of Alaska, delivered an address of welcome. Mr. Wade described some of the economic and geographical links between Alaska, British Columbia and Japan. He referred to the complexity and importance of the high seas fishing problems which confront the Commission and expressed confidence that the Commission would continue to progress toward equitable solutions which would maintain the productivity of the stocks of fish concerned.

Mr. David Levine, President of the Seattle City Council, welcomed the members of the Commission to Seattle and wished them success in solving the fisheries problems confronting the member countries.

Commissioner Koichiro Kobayashi expressed the pleasure of the members of the Japanese delegation at the opportunity to meet again with their colleagues from Canada and the United States. Mr. Kobayashi stressed the dependence of the people of Japan on fisheries products and the consequent necessity for maintaining the North Pacific fisheries on a sustained yield basis. He commended the Commission on its achievements in research and pointed out that many difficult problems remained to be solved. Mr. Kobayashi expressed the belief that the Commission would continue its progress toward solutions of these problems.

Commissioner George R. Clark addressed the opening session on behalf of the Canadian National Section. Mr. Clark called attention to the Commission's obligation to promote and coordinate the scientific studies necessary to ascertain the conservation measures required to secure maximum sustained productivity of fisheries of joint interest and expressed the belief that to achieve these ends there must be some waiver of the right of free fishing. He stated that it was the belief of the Canadian Section that the stocks for which Canada had submitted abstention reports met the qualifications for abstention stated in the Convention. The Canadian Section also believed that the Commission should publish the results obtained to date from its coordinated research program and that the research program itself should be reviewed to determine which investigations are most productive and what additional studies are indicated. In congratulating the Commission on its progress, Mr. Clark again urged that serious consideration be given to conservation measures for securing maximum sustained productivity of fisheries of joint interest.

Commissioner Milton E. Brooding, in his opening address on behalf of the United States National Section, spoke of the considerable benefits that have accrued to the Contracting Parties through the work of the Commission since the Convention came into effect. Benefits have included: order and stability in a situation which was fertile ground for the development of serious clashes of interest; a program of cooperative research on North Pacific fishery problems which is one of the most intensive in the history of fisheries research; a forum in which the nations may discuss and resolve their differences. Research has disclosed a wide area of intermingling of salmon of North American and Asian origin. In particular, substantial numbers of sockeye salmon originating in Bristol Bay have been found west of the provisional abstention line, thus subjecting the Bristol Bay sockeye salmon to both a Japanese and a United States fishery and creating serious fishing and conservation problems. The United States Section continued to hold the belief that this problem could be solved by moving the provisional line to a point west of the occurrence of large numbers of Bristol Bay salmon. It was hoped that either this or some other solution would be forthcoming soon and that in the meantime Japan would refrain from intensive fishing in the area of known substantial intermingling.

Mr. Michael Dederer, President of the Seattle Chamber of Commerce, offered the Commission good wishes for a successful conference and referred to the importance of the Commission's work for the city of Seattle, which is closely associated with all the member nations, with the State of Alaska and with the salmon industry of the North Pacific.

The Chairman of the Commission, Mr. Edward W. Allen, discussed the value of the abstention principle in regional international management of stocks of fish which occupy both high seas and territorial waters. He called attention to the success enjoyed by this Commission and others in their conservation efforts. The need for publication by the Commission of the results of its extensive research program was stressed. Important problems remain for the future and, although the parties concerned have differing points of view on these problems, all are wholly committed to a scientific approach.

5. PROCEDURES FOR THE MEETING

The Commission again reviewed its policy for attendance at plenary sessions. Previously-established policy permits members of the public and press to attend only the opening plenary session; subsequent plenary sessions at each annual meeting may be attended only by accredited participants, including observers. No change was made in the established policy.

Commissioners Hager of Canada, Nishimura of Japan, and Brooding of the United States were designated by their national sections to join with the Chairman of the Commission and the Secretariat in dealing with matters relating to the press.

Procedures for handling other aspects of the meeting followed the Rules of Procedure and precedents established in past years.

6. CONSIDERATION OF ADMINISTRATIVE MATTERS

a. Report of the Chairman

The address of the Chairman of the Commission, Mr. Edward W. Allen of the United States, as given at the opening session, was adopted by the Commission as the Chairman's report. (Item 8, INPFC Doc. 344).

b. Report of the Secretary

The Secretary of the Commission was Mr. Iwao Fujita of Japan. It was agreed that the Administrative Report of the Executive Director (INPFC Doc. 288) presented information on matters which were within the responsibilities of the Secretary of the Commission and that therefore the Administrative Report should also be considered as the report of the Secretary.

c. Report of the Executive Director

The Executive Director submitted the following reports to the Commission on behalf of the Secretariat:

i. Auditors' Report for the fiscal year ended June 30, 1959 (INPFC Doc. 279)

ii. Budget Estimate and Forecast (INPFC Doc. 282)

iii. Administrative Report for 1959 (INPFC Doc. 288)

iv. Second Report on Penalties for Violations of the Convention (Article III (1) (d)). (INPFC Doc. 198)

v. Comments on the Form and Nature of the Reports Submitted in 1959 Under Articles III (1) (c) (iii) and X (2) of the North Pacific Convention (INPFC Doc. 289)

vi. Statistical Yearbook for 1958

These reports were referred to various committees for review. The action taken by the Commission in connection with each report is recorded under the appropriate headings in the remainder of this annual report.

d. Report of the Standing Committee on Finance and Administration

The Commission assigns matters relating to finance and administration to its Standing Committee on Finance and Administration for consideration and report. The Committee, during 1959, was under the chairmanship of Commissioner Roger T. Hager of Canada. Its members are shown in the List of Participants which forms Appendix I of this report. The Committee made a number of recommendations to the Commission, all of which were adopted at the final plenary session. The recommendations as adopted are summarized below:

i. The Committee approved the accounts and report of the Commission's auditors, Peat, Marwick, Mitchell and Company, for the fiscal year ended June 30, 1959, and recommended approval by the Commission. Expenditures for operation of the Commission's Secretariat totalled $48,783.78 (Canadian funds) for the period. The auditors' report appears as an appendix to Part II of this annual report.

ii. The Committee recommended that the Commission adopt a budget totalling $48,690 (Canadian funds) for the operation of its headquarters for the fiscal year beginning July 1, 1960. Each Contracting Party contributes one-third of the funds required for the operation of the Secretariat.

iii. The Committee also presented to the Commission a budget forecast totalling $48,690 (Canadian funds) for the fiscal year beginning July 1, 1961. The budget forecast is intended for the guidance of the national sections and is not to be considered for adoption by the Commission until the Seventh Annual Meeting in 1960.

iv. The Committee recommended that the "Administrative Report for 1959" (INPFC Doc. 288) as prepared by the Executive Director, should be accepted by the Commission. The report in question forms Part II of this annual report.

v. The Committee on Finance and Administration recommended that the Commission accept a report entitled "Second Report on Penalties for Violations of the Convention, (Article III (1) (d))" (INPFC Doc. 198), by the Executive

Director. This report was prepared under instructions given at the 1957 Annual Meeting of the Commission.

vi. The Committee recommended that the Commission accept a report entitled "Comments on the Form and Nature of the Reports Submitted in 1959 Under Articles III (1) (c) (iii) and X (2) of the North Pacific Convention" (INPFC Doc. 289), by the Executive Director.

vii. The Committee noted with pleasure that the Secretariat of the Commission had moved into efficient and attractive new quarters in the Fisheries Technological Station of the Fisheries Research Board of Canada on the campus of the University of British Columbia in Vancouver. These quarters have been made available to the Commission, without charge, by the Government of Canada. The Committee recommended that the Commission send an appropriate letter of appreciation to the Minister of Fisheries, Canada.

viii. The Committee commended the staff of the Commission and particularly Mr. Jackson and Dr. Kasahara for excellent work, for sincere devotion to their duties and for furthering the friendly spirit of cooperation existing between all of those participating in the work of the Commission.

ix. The Committee recommended that the first plenary session of the Seventh Annual Meeting of the Commission should be held on Monday, November 7, 1960, in Vancouver, British Columbia. The Committee further recommended that the period beginning on October 24 and extending to the end of the Seventh Annual Meeting should be designated as the period within which the time and place of committee sessions should be arranged by consultations between the committee chairmen and the Secretariat.

7. IMPLEMENTATION OF THE PROVISIONS OF THE PROTOCOL

a. The Requirement

The Protocol to the North Pacific Convention, the text of which is given in Appendix III of this report, requires the Commission to determine if salmon originating in the rivers of Canada and the United States of America are intermingling in the ocean with salmon originating in the rivers of Asia. If areas of intermingling are found, the Commission is to conduct studies to determine a line or lines which best divide salmon of Asian origin and salmon of North American origin. If it can be shown beyond a reasonable doubt that this line or lines more equitably divide such salmon than the provisional lines given in the Annex to the Convention, the Commission shall recommend that the provisional lines be changed. Otherwise, the Commission shall recommend that they be confirmed.

The Commission has established two committees to assist it in dealing with problems raised by the Protocol. The Standing Committee on Biology and Research is charged with conducting scientific investigations of the distribution, origin and abundance of salmon in the North Pacific Ocean. The Ad Hoc Committee on the Protocol is to study the results of the scientific investigations for the purpose of recommending to the Commission what action, if any, may be desirable or necessary for the discharge of the responsibilities set forth in the Protocol; i.e., whether the provisional lines shall be confirmed or changed.

b. Interpretation of the Protocol

The Ad Hoc Committee on the Protocol is also authorized to consider and report to the Commission on any problem which the Committee finds pertinent to the implementation of the provisions of the Protocol. Since its establishment at the 1958 Annual Meeting, the Ad Hoc Committee on the Protocol has been studying the question of interpretation of the terms of the Protocol. Although the work of the Ad Hoc Committee on the Protocol and its reports to the Commission have been handled on an *in camera* basis, the following resolution with respect to the Protocol was adopted by the Commission and read into the record of the final plenary session of the Sixth Annual Meeting on November 7, 1959:

"The International North Pacific Fisheries Commission reports to the Contracting Parties to the International Convention for the High Seas Fisheries of the North Pacific Ocean that it has studied intensively the Protocol to the Convention but has been unable to arrive at an agreed interpretation of the intent of the Protocol. An agreed interpretation is imperative in order to apply the results of research to confirm or change the Provisional Lines specified in Sections 1 (c) and 2 of the Annex to the Convention. The Commission therefore respectfully requests that the

Contracting Parties provide the International North Pacific Fisheries Commission with an interpretation of the intent of the Protocol as soon as is practicable."

The request for an interpretation of the Protocol was transmitted to the Contracting Parties by the Commission shortly after the adjournment of the Sixth Annual Meeting.

c. Research Progress

For five consecutive years, 1955 to 1959 inclusive, the Commission has continued its program of intensive research on the fisheries problems referred to it by the Convention. Research is conducted by agencies of the various Contracting Parties acting under a program developed and coordinated by the Commission. During 1959 a total of 13 ocean-going research vessels from the three countries took part in various phases of the Commission's program of investigations. The principal activities of these vessels included fishing to collect samples and to determine distribution of salmon on the high seas, oceanographic investigations, capture of salmon for tagging, and research on king crab of the eastern Bering Sea, also a subject of Commission investigation.

In addition to the activities of the research vessels, the Commission's objectives were pursued by a large number of scientists who were engaged in the analysis of data from various sources, including samples from high seas and inshore areas, statistics from the commercial fisheries, the escapements to the spawning grounds and information provided by cooperating agencies and governments.

Insofar as the study of salmon distribution and intermingling problems raised by the Protocol is concerned, the following extract from the report of the Committee on Biology and Research as adopted at the Sixth Annual Meeting (INPFC Doc. 338) will provide a summary of progress:

"1. DISTRIBUTION OF SOCKEYE SALMON

"The general features of sockeye distribution reported in Document 249* were confirmed.

"Further tagging again showed that recoveries of sockeyes tagged along the entire length of the Aleutian Islands were almost all from Bristol Bay or the Japanese high-seas fishery. Morphometric and meristic studies indicated that sockeye of North American origin occurred as far west as 170°E. and dominated most of the samples examined as far as 175°E. in 1956 and at least to 180° in 1957. Scale studies and serological studies were in general agreement with the above findings. Sockeyes with parasites acquired in freshwater in Western Alaska were found as far west as 168°E.

"Studies of morphometric and meristic characters indicated that sockeye of Asiatic origin dominated most of the samples examined west of 175°E. in 1956 and to at least 175°E. in 1957, and that in 1956 they occurred in appreciable quantities as far east as 175°W. south of the Aleutians. Scale studies on 1956 and 1957 samples indicate occurrence of Asiatic sockeye at least to 180° in the Bering Sea and 175°W. south of the Aleutians. Sockeyes with parasites acquired in freshwater in Asia were found as far east as 175°W.

"There is again indication of year-to-year variations in the distribution of sockeye of various origins. Further analysis substantiated statements presented last year that the center of abundance of migrating Bristol Bay sockeyes in the Bering Sea in 1956, 1957 and 1958 shifted by years between 180° and 170°W.

"2. DISTRIBUTION OF PINK SALMON

"The distribution and abundance of pink salmon in 1959 in the waters between 175°E. and 170°W. were very similar to those in 1957.

"It was found, from the results of 1957 tagging experiments, that in 1957 pink salmon bound for East Kamchatka, Karaginsk, Olyutorsk, etc., were distributed as far east as 163°W. Pink salmon tagged in the Aleutian area were not recaptured in the Okhotsk Sea or Asian areas other than East Kamchatka. Preliminary results of 1959 tagging experiments were similar to those of 1957 experiments.

"Considering the results of tagging experiments of the past years together with analysis of catch statistics, it is indicated that Asian pink salmon were predominant in Aleutian waters west of 170°W. in 1957, that a similar tendency was seen in 1959 and that in 1958 the abundance of pink salmon in Aleutian waters was much lower and American pink salmon were found as far west as 177°E.

"From the above findings, it is assumed that

* This report was summarized in the Annual Report of the Commission for 1958.

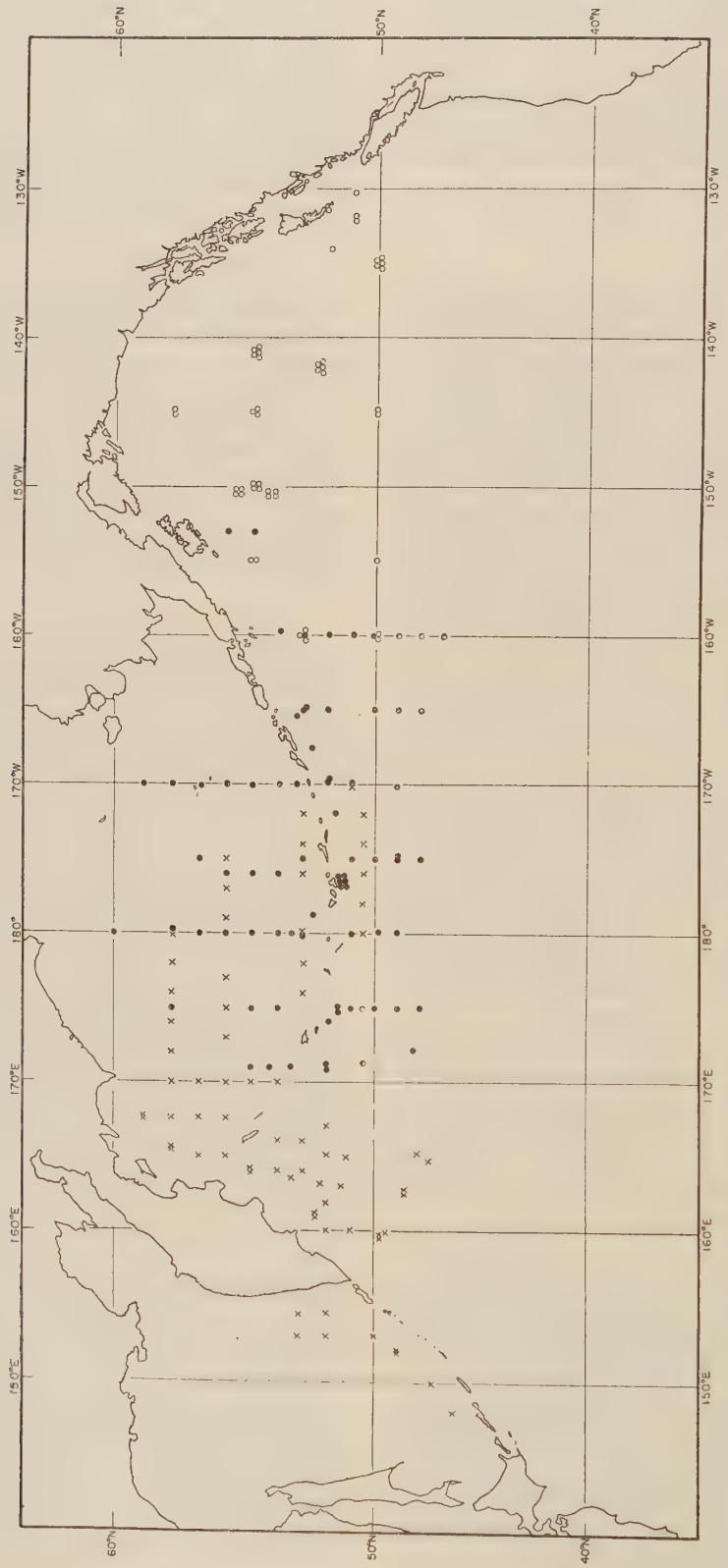


Figure 1. Fishing stations actually occupied by the reseach vessels of the three countries, 1959.

the high seas distribution of pink salmon from both continents changes greatly between odd and even years, that in 1957 and 1959 Asian pink salmon were greatly dominant as far east as approximately 170°W., and that in 1958 Alaskan pink salmon were dominant as far west as approximately 177°E., although their numbers were very small.

" 3. DISTRIBUTION OF CHUM SALMON

" The United States discontinued its studies based on parasites of chum salmon, so that the conclusions reached in 1959 were based on three analytical and experimental techniques; (1) examination of scales, (2) tagging, and (3) comparison of morphological and meristic characters.

" In general, the findings from the three lines of evidence substantiated each other, and corroborated findings recorded in the 1958 report. Analysis of scale circuli counts from 4-year fish in 1957 samples gave evidence of preponderance of fish similar to those found in Asian waters from 175°W. to 180°. Also, body lengths calculated from scales of 1957 4-year fish revealed growth patterns, similar to those of fish found in Asian waters, occurring as far east as 170°–165°W.

" Tagging results, like those of scales, increased the detailed knowledge of distribution (here an additional year's recoveries, those of 1958, were added.) Recoveries covered in the 1958 report showed that American fish extended westward to 177°W. while Asian fish extended eastward to 167°W. Comparable preliminary data reported in 1959 were 177°E. and 164°W., indicating a considerably broader band of intermingling.

" On the basis of the available evidence, the Committee concluded as follows: From 1956 to 1959, chum salmon intermingled over a broad area extending from at least 177°E. along the Aleutians to at least 164°W. south of the Aleutians. Fish with Asian characteristics appeared to have predominated at least as far east as 175°W. in 1956 and 1957. As yet there are not sufficient data to indicate the extent of year-to-year variations in high seas distribution.

" Refinement of techniques and analyses to indicate specific proportions of North American and Asian fish was indicated as a need in the 1958 report and review of the 1959 data shows that this need still exists.

" The Committee agreed that, in addition to the lines of evidence cited above, data on the distribution of North American and Asian chum salmon spawning stocks were essential for a full understanding of the high seas distribution of the species. It recommended a full exchange of information on this subject.

" 4. OCEANOGRAPHY

" Collection of oceanographic data continued in 1959 at about the same rate as in 1958. With the data now on hand it is possible to describe the general oceanographic features of the Subarctic regions in summer.

" It has been agreed that there is evidence in some cases of direct relationships between oceanographic features and salmon distribution, and in other cases these relationships do not appear to hold true.

" More data are needed in order to describe the current systems and other features which may be related to salmon distribution, especially near the Aleutian Islands and in the Bering Sea."

d. Research Plans for 1960

Plans for research during 1960 were developed by the Committee on Biology and Research and submitted to the Commission for approval. The Committee summarized its tentative research plans for 1960 on salmon questions raised by the Protocol as follows. Topics—

A. Offshore distribution of salmon
B. Racial studies
   i. Parasitology
   ii. Meristic characters
   iii. Serology
   iv. Scale characteristics
C. Tagging
D. Oceanography
E. Coordination of activities.

Detailed tentative plans will not be given here but were summarized by the Committee as follows:

"A. The total amount of field work on research under the Protocol assignment will be approximately the same as in the last several years. Within the total program there will be some shifts in emphasis on various aspects of the investigations.

" B. A total of nine research vessels will study the offshore distribution and movements of salmon. Among the activities to be carried on by these vessels are included collection of salmon samples using standardized gillnets, tagging, incidental oceanographic observations and studies of the vertical distribution of salmon.

" C. Studies of the racial and/or continental origin of salmon using samples taken on the high seas and in inshore and fresh waters will be continued. Techniques being applied include parasitology, studies of meristic characters, serology and studies of scale characteristics. In general, it appears that the total effort involved will be about the same as in past years, although parasitological studies will be completed when the samples taken in 1959 have been examined.

" D. Five of the nine vessels mentioned in (B) above will engage in salmon tagging operations in 1960. One Canadian tagging vessel will operate in the eastern part of the Gulf of Alaska; two Japanese vessels will tag salmon west of 165°W. longitude and north of 40°N. latitude and two United States vessels will tag salmon in the region between 165°W. and 170°E.

" E. Plans for oceanographic investigations in 1960 are indicated in Part D of the Report of the Sub-Committee on Research Plans for 1960 (Appendix I). Oceanographic investigations and observations will be continued on about the same scale as in previous years. Canadian vessels will make two oceanographic cruises and Japan will employ one oceanographic vessel during the period from April to September. United States research vessels engaged in studies of the distribution of salmon and tagging of salmon will continue oceanographic investigations, as in the past. The Committee on Biology and Research stresses the need for synoptic oceanographic surveys of the Aleutian Current, as urged in sub-committee reports appended to INPFC Documents 338 and 340.

" F. The Report of the Sub-Committee on Research Plans for 1960 makes a number of practical suggestions for coordination of research activities, including coordination of cruise plans, exchange of samples and data and a joint examination of the techniques for separating fish of Asian and North American origin in high seas samples. The Committee on Biology and Research endorses these proposals for coordination of research activities."

e. Long Range Research Plans

The Commission, acting through its Committee on Biology and Research, has undertaken a thorough review of its research plans for the years beyond 1960. There is some divergence in national views as to the degree to which closer attainment of Protocol objectives can be achieved by continuation of research programs at their present level. Nevertheless, it has been agreed that a thorough review of the problem is needed, in order to determine the types of programs which can yield precise information on specific Protocol objectives, such as:

" a. To determine the exact proportion of continental stocks of the three major species in commercial or research *catches* in finely divided areas of the high seas, both east and east west of the Provisional Line.

" b. To weight these catches according to the *abundance of the stocks* in each area.

" Such precise determinations require further refinement of experimental and analytical techniques, and more detailed data than now available of catch and effort from both mothership fisheries and research vessels.

" It is suggested that the three national sections proceed as follows:

" 1. Appoint a working party of two scientists from each country to work with the Secretariat on the problems of long-term planning of research.

" 2. Ask the Secretariat to prepare a paper making a preliminary assessment of the status of the present program and of the problems involved in planning further research which would be effective in providing answers to questions raised by the Protocol and its associated problems. The Secretariat should have the cooperation of the working party by correspondence.

" 3. Instruct the working party to meet with the Secretariat (perhaps in early summer

in Tokyo, so as to give the Secretariat time to carry out its assignment) and discuss the status of the present program, the need for further research and the prospective value of various lines of research. Further questions might be raised and further work required as a result of this meeting.

" 4. Schedule a thorough discussion of long-term planning just prior to the 1960 Annual Meeting.

" NOTE: The above refers to research on the problems raised by the Protocol, which is already an assigned duty of the Committee on Biology and Research. Should the Commission require broader research, the same mechanism could be used to develop plans."

National views on long-range research plans were submitted to the Commission during the Sixth Annual Meeting by the three national sections. These views will form a portion of the basis for the study and evaluation outlined above.

8. IMPLEMENTATION OF THE PROVISIONS OF ARTICLE III (1) (a) OF THE CONVENTION (ABSTENTION)

Under the provisions of the North Pacific Convention, Japan and, in some cases, Canada refrain from fishing certain stocks of fish, providing that the Contracting Parties which continue to fish these stocks fulfill certain obligations. Japan abstains from fishing salmon and halibut in the eastern Bering Sea and the eastern North Pacific Ocean and also from fishing herring in the eastern North Pacific. Canada abstains from fishing salmon in the eastern Bering Sea. The reader who is not familiar with the portions of the Convention which contain the abstention provisions is advised to read Articles III, IV, and V and the Annex to the Convention, which may be found as Appendix III to this report, beginning on page 18.

The Commission has established an Ad Hoc Committee on Abstention to study and make recommendations on this category of problems. The Committee conducts its business and reports to the Commission on an *in camera* basis. However, at its Sixth Annual Meeting, as was the case in the previous year, the Commission reported the results of its studies on the topic of abstention at its Third and Final Plenary Session. The following is the complete text of the report on the subject of abstention as read into the record of the Third Plenary Session of the Sixth Annual Meeting:

" In accordance with the requirements of Article III (1) (a) of the Convention, the Commission has again studied the status of the North American halibut herring and salmon stocks, which are now under abstention, to determine if they continue to meet the conditions of Article IV of the Convention. With respect to the stocks listed in Sections 1 (a), 1 (c) and 2 of the Annex, no agreement was reached as to whether these stocks continued to qualify for abstention. Therefore the status of these stocks will remain unchanged and abstention by Japan, and in some cases Canada, will continue. The stocks listed in these portions of the Annex include all of the Pacific salmon stocks of North America and all of the halibut off the coast of North America.

" With respect to herring, however, as described in Section 1 (b) of the Annex to the Convention, other action has been taken by the Commission. The action is described in the following recommendation:

" WHEREAS the International North Pacific Fisheries Commission, in performing the functions described in Article III (1) (a) of the Convention, has determined that the herring stocks off the coast of Alaska south of the Alaskan Peninsula and east of the meridian passing through the extremity of the Alaskan Peninsula no longer meet the conditions of Article IV, it is recommended:

" THAT the stocks of herring described above be removed from the Annex to the International Convention for the High Seas Fisheries of the North Pacific Ocean.

" In addition, in relation to the subject of abstention, ' The Commission, on the recommendation of the Ad Hoc Committee on Abstention, approved a proposal to publish the scientific reports submitted in relation to the abstention determinations. An editorial committee for this purpose has been established by the Commission. It is planned to proceed immediately with arrangements for the publication of the abstention reports on herring.' "

Membership of the Ad Hoc Committee on Abstention is given in the List of Participants which forms Appendix II of this report, as is membership of the Scientific Sub-Committee of the Abstention Committee.

9. IMPLEMENTATION OF ARTICLES III (1) (c) (i) AND III (1) (c) (ii) OF THE CONVENTION, WITH RESPECT TO KING CRAB

Under the provisions of Articles III (1) (c) (i) and III (1) (c) (ii) of the Convention, the Commission undertook, at the request of the United States, a study of the king crab stocks of the eastern Bering Sea for the purpose of determining if joint conservation measures by Japan and the United States are needed. The request by the United States was made in 1954 and research on the question began in 1955. The report of the Sub-Committee on King Crab Research shows . . .

" (1) The catch per unit effort in the tangle net fishery shows no decline in the period from 1953 to 1959. Indeed, a rising trend is evident.

" (2) The females and old-shelled males are predominant in the southern and eastern parts of the grounds. New-shelled and undersized-males are more common in the northern and western portions of the area inhabited by king crabs.

" (3) Evidence is shown that an area off Port Moller has contained juvenile king crabs in 1956, 1957, 1958 and 1959."

The above findings were based on Japanese investigations.

Among conclusions presented from United States investigations were the following:

" (1) The distribution of old-shelled males, new-shelled males, and females is as presented . . ." (above).

" (2) Growth rate as estimated on the basis of size increases shown by tagging and size frequency distributions, is about 16 mm. in length (carapace length) at each moult for the crabs greater than 110 mm. in length. When these data are combined with the frequency of moulting for each size of crab, and size frequencies of smaller crabs are considered it was found that a crab 80 mm. (3.2 inches) long required 8 years to reach an average size of 168 mm. (about 6.8 inches)."

The Commission concurred in a finding by its Committee on Biology and Research to the effect that king crab studies have not indicated, to date, that specific recommendations for joint conservation measures with respect to the existing fishery need be made. Such joint conservation measures are contemplated by Article III (1) (c) (ii) of the Convention if the Commission determines that they are needed.

Research organizations of Japan and the United States will continue their investigations of the king crab stocks of the eastern Bering Sea for the Commission in 1960. In general, a long-term research plan established several years ago will continue to be followed. Japan hopes to have a research vessel available for king crab studies in 1960. A scientist aboard the Japanese factory ship will collect catch data, sample the length-frequency of male crabs, collect juvenile crabs, tag crabs and make certain hydrographic observations. The United States research group expects to have a chartered trawler available for its program. Growth studies will be continued by means of tagging and size frequency analysis; migration and mortality rates will be studied by use of tags; estimates of the population will be made by experimental trawling; environmental factors affecting king crab distribution and survival will be studied and changes in meat quantity and quality will be investigated. Exchange of data, tags and research plans, etc., will be continued.

It was recommended that if commercial trawling for other species is undertaken on the king crab grounds of the eastern Bering Sea in 1960 an attempt should be made to estimate the effect of this fishery on the king crab stocks.

10. IMPLEMENTATION OF THE GENERAL PROVISIONS OF THE CONVENTION

At the final plenary session of its Fifth Annual Meeting, on November 10, 1958, the Commission recorded the adoption of a resolution on conservation which was read into the record and subsequently transmitted to the Governments of the three Contracting Parties to the Convention. At the final plenary session of its Sixth Annual Meeting, held on November 7, 1959, the Commission recorded its reaffirmation of the same conservation resolution, which reads as follows:

" In view of the results of scientific investigations to date as contained in the reports of the Committee on Biology and Research and in accordance with the objective of conservation of fishery resources of the North Pacific Ocean, as expressed in the International Convention for the High

Seas Fisheries of the North Pacific Ocean, the Ad Hoc Committee on the Protocol recommends that the International North Pacific Fisheries Commission respectfully recommend to the Governments of the Contracting Parties that full consideration be given to the conservation needs of these fisheries resources in the area of common concern when preparing fishing regulations for future operations."

At its final plenary session the Commission heard views on its progress and problems expressed by spokesmen for the three national sections.

Commissioner Iwao Fujita spoke for the Japanese National Section. He spoke of the severity of the obligation to abstain from fishing, which Japan had accepted under the Convention, and believed that the Contracting Parties fishing stocks protected by abstention were obligated to provide adequate and convincing proof that the qualifications for continued abstention have been met. The scientific discussions held during the current meeting of the Commission had been most appropriate in this regard.

Mr. Fujita referred also to the difficulties facing the Commission in carrying out the research assignments given in the Protocol. Quantitative distribution of salmon on the high seas, its variations and the causative natural factors were questions requiring further investigation. Under the Convention Japan's only obligation is to abstain from fishing certain stocks in areas east of the Provisional Abstention Lines. However, Japan is also much concerned with the conservation of salmon resources in the North Pacific Ocean and is accordingly enforcing the necessary domestic measures of restriction whether or not they are international obligations. Continued frankness in exchanging views, in accordance with the spirit of the Convention, should be of assistance to the Commission's work in the future.

Commissioner George R. Clark, speaking for the Canadian Section at the closing plenary session, commended the Commissioners and scientists of all national sections for their devotion to the tasks assigned by the Convention. He stressed the value of the Commission's research program to the three member nations and congratulated the Commission on the progress achieved at the Sixth Annual Meeting.

Commissioner Milton E. Brooding, speaking for the United States National Section, complimented the Commissioners and their scientists, experts and advisors and the Secretariat on their cooperative and diligent attention to the Commission's problems. Mr. Brooding reviewed the progress the Commission has made with respect to the stocks under abstention—salmon, halibut and herring. He concluded that the Commission's recommendation that herring off the coast of Alaska should be withdrawn from abstention, while hardly to the immediate liking of the United States Section, was a demonstration that the abstention principle of the Convention was workable.

Referring to questions arising from the Protocol to the Convention, Mr. Brooding expressed concern over the Commission's lack of agreement on such questions. No progress could be made on establishment of a new abstention line until the Contracting Parties had given the Commission an agreed interpretation of the Protocol.

In closing, Mr. Brooding expressed his Section's disappointment that the Commission had not taken new action on the problem of conservation of salmon in the area of substantial intermingling. He noted that the Commission had reaffirmed the conservation resolution adopted in 1958 but expressed great concern over the vulnerability of the Bristol Bay sockeye runs if all the fisheries operating on those stocks were not adequately regulated.

11. OTHER MATTERS

a. Statistical Yearbook

The Commission, on recommendation of the Committee on Biology and Research, accepted the Statistical Yearbook for 1958, as prepared by the Secretariat. The Commission also adopted a recommendation that future volumes of the yearbook should contain the names of the compilers and that, if possible, it be printed on better and more permanent paper and given wider distribution, within the limits of available funds. Attention was drawn to the need for more detailed past and future catch and effort statistics for the Japanese high-seas mothership salmon fishery and the Committee on Biology and Research was informed that in spite of many difficulties in presenting statistics in greater detail, attempts were being made to provide such information.

b. Publications

The Commission, acting on recommendation of its Committee on Biology and Research, clarified

and extended its publication policy, with the objective of expediting publication of results of research under the Commission's program. Particular attention was paid to the problem of publication of results of research conducted by workers from more than one of the member countries. To this end, the following resolution was adopted:

> " That the Editorial Committee with the assistance of the Secretariat be instructed to arrange as expeditiously as possible for joint reporting of appropriate phases of the research program and to develop plans for the eventual joint reporting of appropriate phases of the results of the research program as a whole."

Present members of the Editorial Committee are Dr. A.W.H. Needler for Canada, Dr. Hiroaki Aikawa for Japan and Mr. Donald L. McKernan for the United States. The Secretariat was instructed to prepare a study of plans for producing joint reports on the results of research.

A working party consisting of scientists from the three member countries was established to work towards a joint report on the distribution of salmon on the high seas of the North Pacific Ocean.

The Commission also accepted a recommendation of the Committee on Biology and Research for a comprehensive joint study and reporting of the oceanographic data that has been collected in the Subarctic region of the North Pacific Ocean by qualified representatives of Japan, Canada and the United States. Work on this study is to go forward with all reasonable speed.

As mentioned earlier in this report, the Commission also agreed, in principle, to publication of the materials submitted by the Contracting Parties with respect to the abstention qualifications of salmon, halibut and herring stocks of the eastern North Pacific. All of the reports relating to herring were released for publication and arrangements were made for the work to go ahead as rapidly as possible.

12. NEW OFFICERS

At the final plenary session of the Sixth Annual Meeting the Commission elected the following new officers, all of whose terms began with the close of the meeting and will terminate with the close of the Seventh Annual Meeting in 1960:

Chairman of the Commission—Mr. George R. Clark of Canada.

Vice-Chairman of the Commission—Mr. Iwao Fujita of Japan.

Secretary of the Commission—Mr. Edward W. Allen of the United States.

Chairman of the Committee on Biology and Research—Mr. John H. Clawson of the United States.

Chairman of the Committee on Finance and Administration—Mr. Kenjiro Nishimura of Japan.

Mr. George R. Clark of Canada was elected as Chairman of both the Ad Hoc Committee on the Protocol and the Ad Hoc Committee on Abstention until such times as their next meetings are convened. The Scientific Sub-Committee of the Ad Hoc Committee on Abstention followed a practice of rotating its chairmanship daily between scientists from the three countries.

13. FUTURE MEETINGS

The Seventh Annual Meeting of the Commission will begin in Vancouver, British Columbia, on November 7, 1960. The period beginning two weeks prior to that date has been designated as the period within which the time and place of committee meetings may be arranged by their respective chairmen, in consultation with the Secretariat.

APPENDIX I

LIST OF PARTICIPANTS

OFFICERS OF THE MEETING

CHAIRMAN
Edward W. Allen, United States

VICE-CHAIRMAN
George R. Clark, Canada

SECRETARY
Iwao Fujita, Japan

CANADA

Commissioners

George R. Clark,
Ottawa, Canada

John M. Buchanan,
Vancouver, B.C.

James C. Cameron,
Madeira Park, B.C.

Roger T. Hager,
Vancouver, B.C.

Advisors and Experts

A. W. H. Needler
W. M. Sprules
J. L. Kask
Ferris Neave
M. P. Shepard
K. S. Ketchen
W. E. Ricker
L. Margolis
J. P. Tully
R. E. Foerster
F. H. C. Taylor
J. I. Manzer
A. J. Dodimead
T. H. Bilton
F. C. Withler
A. J. Whitmore
J. C. Stevenson
H. Godfrey
C. E. Chatillon

JAPAN

Commissioners

Iwao Fujita,
Tokyo, Japan

Kenjiro Nishimura,
Tokyo, Japan

Koichiro Kobayashi,
Tokyo, Japan

Advisors and Experts

Y. Takeno
M. Tanabe
K. Arita
K. Kawakami
T. Chaki
C. Yamada
T. Isogai
H. Aikawa
Y. Fukuda
T. Matsushita
S. Tanaka
T. Ishida
M. Fujinaga
K. Taguchi

UNITED STATES

Commissioners

Milton E. Brooding,
San Francisco, California
Edward W. Allen,
Seattle, Washington
John H. Clawson,
Anchorage, Alaska
Arnie J. Suomela,
Washington, D.C.

Advisors

C. E. Atkinson
D. Chapman
R. A. Fredin
W. C. Herrington
D. P. Loker
J. L. McHugh
D. L. McKernan
W. F. Royce
R. J. Tepper
W. M. Terry
W. F. Thompson
W. G. Van Campen

Advisory Committee

C. L. Anderson
W. C. Arnold
H. F. Cary
R. S. Croker
A. M. Day
DeWitt Gilbert
W. Kirkness (alternate)
M. C. James
G. Johansen
R. C. Kallenberg
H. E. Lokken
M. Moore
A. Owen
C. Pautzke (alternate)
T. F. Sandoz
J. W. Smith
L. Wakefield
J. Waugh

Experts

R. Anas
R. L. Burgner
C. J. Burner
F. C. Cleaver
C. J. DiConstanzo
R. Duncan
F. Favorite
F. Fukuhara
J. T. Gharrett
M. G. Hanavan
G. Harry
A. C. Hartt
S. J. Hutchinson
B. F. Jones
J. LaLanne
R. L. Lander
T. S. W. Koo
O. A. Mathisen
T. Miyahara
K. H. Mosher
S. Murai
A. E. Peterson
G. J. Ridgway
R. P. Silliman
D. D. Worlund

OBSERVERS

Food and Agriculture Organization of the United Nations

James A. Crutchfield,
Seattle, Washington

International Pacific Halibut Commission

Harold A. Dunlop,
F. Heward Bell,
W. H. Hardman,
R. J. Myhre,
M. Southward,
A. T. Pruter,
G. J. Peltonen
W. L. High,
R. Kautz,
all of Seattle, Washington.

International Pacific Salmon Fisheries Commission

Loyd A. Royal, New Westminster, B.C.
Kenneth Henry, New Westminster, B.C.

International Commission for the Northwest Atlantic Fisheries

Arnie J. Suomela,
Washington, D. C.

Union of Soviet Socialist Republics

Mikhail Nikitich Mironov,
Moscow, U.S.S.R.

Orest Sergeevich Tyminsky,
(Interpreter)

SECRETARIAT

Permanent

Roy I. Jackson,
Executive Director.

Hiroshi Kasahara,
Assistant Director

Lorraine M. Kissack,
Secretary

Temporary

H. Ozaki
K. Kitano
L. Nakatsu
K. Tsuruta
H. Kim
K. Hirai
V. Antenucci
E. Wells

MEMBERSHIP OF COMMITTEES

1. STANDING COMMITTEE ON FINANCE AND ADMINISTRATION

CANADA

Commissioner-members ..... Roger T. Hager, Chairman
John M. Buchanan
Commissioner-advisor ..... George R. Clark

JAPAN

Commissioner-member ..... Kenjiro Nishimura
Advisor-member ..... Keisuke Arita
Advisor ..... Chusei Yamada

UNITED STATES

Commissioner-member ..... Arnie J. Suomela
Advisor-member ..... Donald P. Loker
Advisor ..... W. M. Terry

SECRETARIAT

Ex-officio members ..... Roy I. Jackson
Hiroshi Kasahara

2. STANDING COMMITTEE ON BIOLOGY AND RESEARCH

CANADA

Commissioner-member	James C. Cameron
Advisor-members	A. W. H. Needler
	W. M. Sprules

JAPAN

Commissioner-member	Koichiro Kobayashi, Chairman
Advisor-members	Hiroaki Aikawa
	Tomonari Matsushita

UNITED STATES

Commissioner-member	John H. Clawson
Advisor-members	D. L. McKernan Convenor
	W. F. Royce

SECRETARIAT

Ex-officio members	Roy I. Jackson
	Hiroshi Kasahara

3. AD HOC COMMITTEE ON ABSTENTION

CANADA

Commissioner-member	George R. Clark, Chairman
Commissioner-advisor	James C. Cameron
Advisors	A. W. H. Needler
	W. M. Sprules
	M. P. Shepard
	K. S. Ketchen
	F. H. C. Taylor
	W. E. Ricker
	A. J. Whitmore
	J. C. Stevenson
	C. E. Chatillon

JAPAN

Commissioner-member	Iwao Fujita
Commissioner-advisors	Kenjiro Nishimura
	Koichiro Kobayashi
Advisors	Y. Takeno
	M. Tanabe
	K. Arita
	K. Kawakami
	T. Chaki

UNITED STATES

Commissioner-member	Edward W. Allen
Commissioner-advisors	Milton E. Brooding
	Arnie J. Suomela
Advisors	D. L. McKernan
	W. C. Herrington
	W. M. Terry
	C. E. Atkinson
	R. A. Fredin
	H. E. Lokken
	R. C. Kallenberg
	W. G. Van Campen
	J. L. McHugh
	C. L. Anderson
	R. J. Tepper
	C. Yamada
	T. Isogai
	H. Aikawa
	Y. Fukuda
	T. Matsushita
	S. Tanaka
	T. Ishida
	K. Taguchi

4. AD HOC COMMITTEE ON THE PROTOCOL

CANADA

Commissioner-member	George R. Clark, Chairman
Commissioner-advisor	John M. Buchanan
Advisors	A. W. H. Needler
	W. M. Sprules
	M. P. Shepard
	L. Margolis
	C. E. Chatillon

UNITED STATES

Commissioner-member	Milton E. Brooding
Commissioner-advisor	Edward W. Allen
Advisors	W. C. Herrington
	D. L. McKernan
	W. M. Terry
	W. G. Van Campen
	C. L. Anderson
	R. J. Tepper

JAPAN

Commissioner-member	Kenjiro Nishimura
Commissioner-advisor	Iwao Fujita
	Koichiro Kobayashi
Advisors	T. Takeno
	M. Tanabe
	K. Arita
	K. Kawakami
	T. Chaki
	C. Yamada
	T. Isogai
	H. Aikawa
	Y. Fukuda
	T. Matsushita
	S. Tanaka
	T. Ishida
	K. Taguchi

5. SCIENTIFIC SUB-COMMITTEE OF THE AD HOC COMMITTEE ON ABSTENTION

CANADA

Member ..... A. W. H. Needler
Advisors ..... K. S. Ketchen
W. E. Ricker
M. P. Shepard
F. H. C. Taylor

JAPAN

Member ..... Hiroaki Aikawa
Advisors ..... M. Fujinaga
Y. Fukuda
S. Tanaka
T. Matsushita
T. Isogai
K. Taguchi
M. Tanabe

UNITED STATES

Member ..... D. L. McKernan
Advisors ..... C. E. Atkinson
D. Chapman
C. DiConstanzo
R. A. Fredin
J. L. McHugh

SECRETARIAT

R. I. Jackson
H. Kasahara

APPENDIX II

AGENDA

as adopted at the

SIXTH ANNUAL MEETING—1959

Seattle, Washington, November 2 to 7, 1959

1. Call to order
2. Introductions
3. Addresses of welcome and responses
4. Adoption of agenda
5. Report on delegation memberships
6. Meeting procedures
   - (a) Attendance at meetings
   - (b) Schedule of sessions
   - (c) Press policy
   - (d) Minutes
7. Report of the Chairman
8. Report of the Secretary
9. Submission of reports by the Executive Director
10. Consideration of various matters previously referred to the Committee on Biology and Research
    - (a) Research phase of the Protocol to the Convention
    - (b) King crab research (Article III (1) (c) (i))
    - (c) Long-range research plans
    - (d) Statistics (Article III (1) (e))
    - (e) Publication of scientific reports
    - (f) Other matters
11. Report of the Committee on Biology and Research
12. Consideration of salmon problems in high seas areas of intermingling
13. Implementation of the Protocol
14. Report of the Ad Hoc Committee on the Protocol
15. Implementation of Article III (1) (a) of the Convention with respect to the stocks listed in the Annex:
    - (a) Halibut (Annex par. 1 (a))
    - (b) Herring (Annex par. 1 (b))
    - (c) Salmon of the northeastern North Pacific (Annex par. 1 (c))
    - (d) Salmon of the eastern Bering Sea (Annex par. 2)
16. Report of the Ad Hoc Committee on Abstention
17. Implementation of Article III (1) (c) (ii) with respect to king crab
18. Consideration of administrative and fiscal matters
    - (a) Accounts and audit
    - (b) Budget for fiscal year beginning July 1, 1960
    - (c) Budget forecast for fiscal year beginning July 1, 1961
    - (d) Administrative report by the Executive Director
    - (e) Second report on penalties for violations of the Convention (Article III (1) (d))
    - (f) Comments on the form and nature of the reports submitted under Articles III (1) (c) (iii) and X (2)
    - (g) Schedule of meetings for the forthcoming year
    - (h) Other business
19. Report of the Committee on Finance and Administration
20. Election of officers
21. Other business
22. Adjournment

APPENDIX III

INTERNATIONAL CONVENTION FOR THE HIGH SEAS FISHERIES OF THE NORTH PACIFIC OCEAN

Signed at Tokyo, May 9, 1952.
Ratified by the United States, July 30, 1952.
Ratified by Canada, May 15, 1953.
Ratified by Japan, June 9, 1953.
Ratifications exchanged at Tokyo, June 12, 1953.
Entered into force, June 12, 1953.

The Governments of Canada, Japan and the United States of America, whose respective duly accredited representatives have subscribed hereto,

Acting as sovereign nations in the light of their rights under the principles of international law and custom to exploit the fishery resources of the high seas, and

Believing that it will best serve the common interest of mankind, as well as the interests of the Contracting Parties, to ensure the maximum sustained productivity of the fishery resources of the North Pacific Ocean, and that each of the Parties should assume an obligation, on a free and equal footing, to encourage the conservation of such resources, and

Recognizing that in view of these considerations it is highly desirable (1) to establish an International Commission, representing the three Parties hereto, to promote and coordinate the scientific studies necessary to ascertain the conservation measures required to secure the maximum sustained productivity of fisheries of joint interest to the Contracting Parties and to recommend such measures to such Parties and (2) that each Party carry out such conservation recommendations, and provide for necessary restraints on its own nationals and fishing vessels,

Therefore agree as follows:

ARTICLE I.

1. The area to which this Convention applies, hereinafter referred to as " the Convention area ", shall be all waters, other than territorial waters, of the North Pacific Ocean which for the purposes hereof shall include the adjacent seas.

2. Nothing in this Convention shall be deemed to affect adversely (prejudice) the claims of any Contracting Party in regard to the limits of territorial waters or to the jurisdiction of a coastal state over fisheries.

3. For the purposes of this Convention the term " fishing vessel " shall mean any vessel engaged in catching fish or processing or transporting fish loaded on the high seas, or any vessel outfitted for such activities.

ARTICLE II.

1. In order to realize the objectives of this Convention, the Contracting Parties shall establish and maintain the International North Pacific Fisheries Commission, hereinafter referred to as " the Commission."

2. The Commission shall be composed of three national sections, each consisting of not more than four members appointed by the governments of the respective Contracting Parties.

3. Each national section shall have one vote. All resolutions, recommendations and other decisions of the Commission shall be made only by a unanimous vote of the three national sections except when under the provisions of Article III, Section 1 (*c*) (ii) only two participate.

4. The Commission may decide upon and amend, as occasion may require, by-laws or rules for the conduct of its meetings.

5. The Commission shall meet at least once each year and at such other times as may be requested by a majority of the national sections. The date and place of the first meeting shall be determined by agreement between the Contracting Parties.

6. At its first meeting the Commission shall select a Chairman, Vice-Chairman and Secretary from different national sections. The Chairman, Vice-Chairman and Secretary shall hold office for a period of one year. During succeeding years selection of a Chairman, Vice-Chairman and Secretary from the national sections shall be made in such a manner as will provide each Contracting Party in turn with representation in those offices.

7. The Commission shall decide on a con-

venient place for the establishment of the Commission's headquarters.

8. Each Contracting Party may establish an Advisory Committee for its national section, to be composed of persons who shall be well informed concerning North Pacific fishery problems of common concern. Each such Advisory Committee shall be invited to attend all sessions of the Commission except those which the Commission decides to be *in camera*.

9. The Commission may hold public hearings. Each national section may also hold public hearings within its own country.

10. The official languages of the Commission shall be Japanese and English. Proposals and data may be submitted to the Commission in either language.

11. Each Contracting Party shall determine and pay the expenses incurred by its national section. Joint expenses incurred by the Commission shall be paid by the Commission through contributions made by the Contracting Parties in the form and proportion recommended by the Commission and approved by the Contracting Parties.

12. An annual budget of joint expenses shall be recommended by the Commission and submitted to the Contracting Parties for approval.

13. The Commission shall authorize the disbursement of funds for the joint expenses of the Commission and may employ personnel and acquire facilities necessary for the performance of its functions.

ARTICLE III.

1. The Commission shall perform the following functions:

(*a*) In regard to any stock of fish specified in the Annex, study for the purpose of determining annually whether such stock continues to qualify for abstention under the provisions of Article IV. If the Commission determines that such stock no longer meets the conditions of Article IV, the Commission shall recommend that it be removed from the Annex. Provided, however, that with respect to the stocks of fish originally specified in the Annex, no determination or recommendation as to whether such stock continues to qualify for abstention shall be made for five years after the entry into force of this Convention.

(*b*) To permit later additions to the Annex, study, on request of a Contracting Party, any stock of fish of the Convention area, the the greater part of which is harvested by one or more of the Contracting Parties, for the purpose of determining whether such stock qualifies for abstention under the provisions of Article IV. If the Commission decides that the particular stock fulfills the conditions of Article IV it shall recommend, (1) that such stock be added to the Annex, (2) that the appropriate Party or Parties abstain from fishing such stock and (3) that the Party or Parties participating in the fishing of such stock continue to carry out necessary conservation measures.

(*c*) In regard to any stock of fish in the Convention area;

(i) Study, on request of any Contracting Party concerned, any stock of fish which is under substantial exploitation by two or more of the Contracting Parties, and which is not covered by a conservation agreement between such Parties existing at the time of the conclusion of this Convention, for the purpose of determining need for joint conservation measures;

(ii) Decide and recommend necessary joint conservation measures including any relaxation thereof to be taken as a result of such study. Provided, however, that only the national sections of the Contracting Parties engaged in substantial exploitation of such stock of fish may participate in such decision and recommendation. The decisions and recommendations shall be reported regularly to all the Contracting Parties, but shall apply only to the Contracting Parties the national sections of which participated in the decisions and recommendations.

(iii) Request the Contracting Party or Parties concerned to report regularly the conservation measures adopted from time to time with regard to the

stocks of fish specified in the Annex, whether or not covered by conservation agreements between the Contracting Parties, and transmit such information to the other Contracting Party or Parties.

(*d*) Consider and make recommendations to the Contracting Parties concerning the enactment of schedules of equivalent penalties for violations of this Convention.

(*e*) Compile and study the records provided by the Contracting Parties pursuant to Article VIII.

(*f*) Submit annually to each Contracting Party a report on the Commission's operations, investigations and findings, with appropriate recommendations, and inform each Contracting Party, whenever it is deemed advisable, on any matter relating to the objectives of this Convention.

2. The Commission may take such steps, in agreement with the Parties concerned, as will enable it to determine the extent to which the undertakings agreed to by the Parties under the provisions of Article V, Section 2 and the measures recommended by the Commission under the provisions of this Article and accepted by the Parties concerned have been effective.

3. In the performance of its functions, the Commission shall, insofar as feasible, utilize the technical and scientific services of, and information from, official agencies of the Contracting Parties and their political sub-divisions and may, when desirable and if available, utilize the services of, and information from, any public or private institution or organization or any private individual.

ARTICLE IV.

1. In making its recommendations the Commission shall be guided by the spirit and intent of this Convention and by the considerations below mentioned.

(*a*) Any conservation measures for any stock of fish decided upon under the provisions of this Convention shall be recommended for equal application to all Parties engaged in substantial exploitation of such stock.

(*b*) With regard to any stock of fish which the Commission determines reasonably satisfies all the following conditions, a recommendation shall be made as provided for in Article III, Section 1 (*b*).

(i) Evidence based upon scientific research indicates that more intensive exploitation of the stock will not provide a substantial increase in yield which can be sustained year after year,

(ii) The exploitation of the stock is limited or otherwise regulated through legal measures by each Party which is substantially engaged in its exploitation, for the purpose of maintaining or increasing its maximum sustained productivity; such limitations and regulations being in accordance with conservation programs based upon scientific research, and

(iii) The stock is the subject of extensive scientific study designed to discover whether the stock is being fully utilized and the conditions necessary for maintaining its maximum sustained productivity.

Provided, however, that no recommendation shall be made for abstention by a Contracting Party concerned with regard to: (1) any stock of fish which at any time during the twenty-five years next preceding the entry into force of this Convention has been under substantial exploitation by that Party having regard to the conditions referred to in Section 2 of this Article; (2) any stock of fish which is harvested in greater part by a country or countries not party to this Convention; (3) waters in which there is historic intermingling of fishing operations of the Parties concerned, intermingling of the stocks of fish exploited by these operations, and a long-established history of joint conservation and regulation among the Parties concerned so that there is consequent impracticability of segregating the operations and administering control. It is recognized that the conditions specified in subdivision (3) of this proviso apply to Canada and the United States of America in the waters off the Pacific Coasts of the United States of America and Canada from and including the waters of the Gulf of Alaska southward and, therefore, no recommendation shall be made for abstention by either the United States of America or Canada in such waters.

2. In any decision or recommendation allowances shall be made for the effect of strikes, wars,

or exceptional economic or biological conditions which may have introduced temporary declines in or suspension of productivity, exploitation, or management of the stock of fish concerned.

ARTICLE V.

1. The Annex attached hereto forms an integral part of this Convention. All references to "Convention" shall be understood as including the said Annex either in its present terms or as amended in accordance with the provisions of Article VII.

2. The Contracting Parties recognize that any stock of fish originally specified in the Annex to this Convention fulfills the conditions prescribed in Article IV and accordingly agree that the appropriate Party or Parties shall abstain from fishing such stock and the Party or Parties participating in the fishing of such stock shall continue to carry out necessary conservation measures.

ARTICLE VI.

In the event that it shall come to the attention of any of the Contracting Parties that the nationals or fishing vessels of any country which is not a Party to this Convention appear to affect adversely the operations of the Commission or the carrying out of the objectives of this Convention, such Party shall call the matter to the attention of other Contracting Parties. All the Contracting Parties agree upon the request of such Party to confer upon the steps to be taken towards obviating such adverse effects or relieving any Contracting Party from such adverse effects.

ARTICLE VII.

1. The Annex to this Convention shall be considered amended from the date upon which the Commission receives notification from all the Contracting Parties of acceptance of a recommendation to amend the Annex made by the Commission in accordance with the provisions of Article III, Section 1 or of the Protocol to this Convention.

2. The Commission shall notify all the Contracting Parties of the date of receipt of each notification of acceptance of an amendment to the Annex.

ARTICLE VIII.

The Contracting Parties agree to keep as far as practicable all records requested by the Commission and to furnish compilations of such records and other information upon request of the Commission. No Contracting Party shall be required hereunder to provide the records of individual operations.

ARTICLE IX.

1. The Contracting Parties agree as follows:

(*a*) With regard to a stock of fish from the exploitation of which any Contracting Party has agreed to abstain, the nationals and fishing vessels of such Contracting Party are prohibited from engaging in the exploitation of such stock of fish in waters specified in the Annex, and from loading, processing, possessing, or transporting such fish in such waters.

(*b*) With regard to a stock of fish for which a Contracting Party has agreed to continue to carry out conservation measures, the nationals and fishing vessels of such Party are prohibited from engaging in fishing activities in waters specified in the Annex in violation of regulations established under such conservation measures.

2. Each Contracting Party agrees, for the purpose of rendering effective the provisions of this Convention, to enact and enforce necessary laws and regulations, with regard to its nationals and fishing vessels, with appropriate penalties against violations thereof and to transmit to the Commission a report on any action taken by it with regard thereto.

ARTICLE X.

1. The Contracting Parties agree, in order to carry out faithfully the provisions of this Convention, to cooperate with each other in taking appropriate and effective measures and accordingly agree as follows:

(*a*) When a fishing vessel of a Contracting Party has been found in waters in which that Party has agreed to abstain from exploitation in accordance with the provisions of this Convention, the duly authorized officials of any Contracting Party may board such vessel to inspect its equipment, books, documents, and other articles and question the persons on board.

Such officials shall present credentials issued by their respective Governments if requested by the master of the vessel.

(*b*) When any such person or fishing vessel is actually engaged in operations in violation of the provisions of this Convention, or there is reasonable ground to believe was obviously so engaged immediately prior to boarding of such vessel by any such official, the latter may arrest or seize such person or vessel. In that case, the Contracting Party to which the official belongs shall notify the Contracting Party to which such person or vessel belongs of such arrest or seizure, and shall deliver such vessel or persons as promptly as practicable to the authorized officials of the Contracting Party to which such vessel or person belongs at a place to be agreed upon by both Parties. Provided, however, that when the Contracting Party which receives such notification cannot immediately accept delivery and makes request, the Contracting Party which gives such notification may keep such person or vessel under surveillance within its own territory, under the conditions agreed upon by both of the Contracting Parties.

(*c*) Only the authorities of the Party to which the above-mentioned person or fishing vessel belongs may try the offense and impose penalties therefor. The witnesses and evidence necessary for establishing the offense, so far as they are under the control of any of the Parties to this Convention, shall be furnished as promptly as possible to the Contracting Party having jurisdiction to try the offense.

2. With regard to the nationals or fishing vessels of one or more Contracting Parties in waters with respect to which they have agreed to continue to carry out conservation measures for certain stocks of fish in accordance with the provisions of this Convention, the Contracting Parties concerned shall carry out enforcement severally or jointly. In that case, the Contracting Parties concerned agree to report periodically through the Commission to the Contracting Party which has agreed to abstain from the exploitation of such stocks of fish on the enforcement conditions, and also, if requested, to provide opportunity for observation of the conduct of enforcement.

3. The Contracting Parties agree to meet, during the sixth year of the operation of this Convention to review the effectiveness of the enforcement provisions of this Article and, if desirable, to consider means by which they may more effectively be carried out.

ARTICLE XI.

1. This Convention shall be ratified by the Contracting Parties in accordance with their respective constitutional processes and the instruments of ratification shall be exchanged as soon as possible at Tokyo.

2. This Convention shall enter into force on the date of the exchange of ratifications. It shall continue in force for a period of ten years and thereafter until one year from the day on which a Contracting Party shall give notice to the other Contracting Parties of an intention of terminating the Convention, whereupon it shall terminate as to all Contracting Parties.

IN WITNESS WHEREOF, the respective Plenipotentiaries, duly authorized, have signed the present Convention.

DONE in triplicate, in the English and Japanese languages, both equally authentic, at Tokyo this ninth day of May, one thousand nine hundred and fifty-two.

CANADA:

(Sgd.) A. R. Menzies

JAPAN:

(Sgd.) K. Okazaki
(Sgd.) K. Hirokawa

UNITED STATES OF AMERICA:

(Sgd.) Robert Murphy

ANNEX.

1. With regard to the stocks of fish in the respective waters named below, Japan agrees to abstain from fishing, and Canada and the United States of America agree to continue to carry out necessary conservation measures, in accordance with the provisions of Article V, Section 2 of this Convention:

(*a*) Halibut (*Hippoglossus stenolepis*)
The Convention area off the coasts of Canada and the United States of America in which commercial fishing for halibut is being or can be prosecuted. Halibut referred to herein shall be those originating along the coast of North America.

(*b*) Herring (*Clupea pallasii*)*
The Convention area off the coast of

* As Amended May 24, 1960.

Canada and off the coast of the United States of America south of the entrance to the Strait of Juan de Fuca in which commercial fishing for herring of North American origin is being or can be procecuted.

(*c*) Salmon (*Oncorhynchus gorbuscha, Oncorhynchus keta, Oncorhynchus kisutch, Oncorhynchus nerka, Oncorhynchus tschawytscha*)
The Convention area off the coasts of Canada and the United States of America, exclusive of the Bering Sea and of the waters of the North Pacific Ocean west of a provisional line following the meridian passing through the western extremity of Atka Island; in which commercial fishing for salmon originating in the rivers of Canada and the United States of America is being or can be prosecuted.

2. With regard to the stocks of fish in the waters named below, Canada and Japan agree to abstain from fishing, and the United States of America agrees to continue to carry out necessary conservation measures, in accordance with the provisions of Article V, Section 2 of this Convention:

Salmon (*Oncorhynchus gorbuscha, Oncorhynchus keta, Oncorhynchus kisutch, Oncorhynchus nerka* and *Oncorhynchus tschawytscha*)
The Convention area of the Bering Sea east of the line starting from Cape Prince of Wales on the west coast of Alaska, running westward to 168°58′22.59″ West Longitude; thence due south to a point 65°15′00″ North Latitude; thence along the great circle course which passes through 51° North Latitude and 167° East Longitude, to its intersection with meridian 175° West Longitude; thence south along a provisional line which follows this meridian to the territorial waters limit of Atka Island; in which commercial fishing for salmon originating in the rivers of the United States of America is being or can be prosecuted.

PROTOCOL TO THE INTERNATIONAL CONVENTION FOR THE HIGH SEAS FISHERIES OF THE NORTH PACIFIC OCEAN.

The Governments of Canada, Japan and the United States of America, through their respective Plenipotentiaries, agree upon the following stipulation in regard to the International Convention for the High Seas Fisheries of the North Pacific Ocean, signed at Tokyo on this ninth day of May, nineteen hundred fifty-two.

The Governments of Canada, Japan and the United States of America agree that the line of meridian 175° West Longitude and the line following the meridian passing through the western extremity of Atka Island, which have been adopted for determining the areas in which the exploitation of salmon is abstained or the conservation measures for salmon continue to be enforced in accordance with the provisions of the Annex to this Convention, shall be considered as provisional lines which shall continue in effect subject to confirmation or readjustment in accordance with the procedure mentioned below.

The Commission to be established under the Convention shall, as expeditiously as practicable, investigate the waters of the Convention area to determine if there are areas in which salmon originating in the rivers of Canada and of the United States of America intermingle with salmon originating in the rivers of Asia. If such areas are found the Commission shall conduct suitable studies to determine a line or lines which best divide salmon of Asiatic origin and salmon of Canadian and United States of America origin, from which certain Contracting Parties have agreed to abstain in accordance with the provisions of Article V, Section 2, and whether it can be shown beyond a reasonable doubt that this line or lines more equitably divide such salmon than the provisional lines specified in sections 1 (*c*) and 2 of the Annex. In accordance with these determinations the Commission shall recommend that such provisional lines be confirmed or that they be changed in accordance with these results, giving due consideration to adjustments required to simplify administration.

In the event, however, the Commission fails within a reasonable period of time to recommend unanimously such line or lines, it is agreed that the matter shall be referred to a special committee of scientists consisting of three competent and disinterested persons, no one of whom shall be a national of a Contracting Party, selected by mutual agreement of all Parties for the determination of this matter.

It is further agreed that when a determination has been made by a majority of such special committee, the Commission shall make a recommendation in accordance therewith.

The Governments of Canada, Japan and the United States of America, in signing this Protocol, desire to make it clear that the procedure set forth herein is designed to cover a special situation. It is not, therefore, to be considered a precedent for the final resolution of any matters which may, in the future, come before the Commission.

This Protocol shall become effective from the date of entry into force of the said Convention.

IN WITNESS WHEREOF, the respective Plenipotentiaries have signed this Protocol.

DONE in triplicate at Tokyo this ninth day of May, one thousand nine hundred fifty-two.

CANADA:

(Sgd.) A. R. Menzies

JAPAN:

(Sgd.) K. Okazaki
(Sgd.) K. Hirokawa

UNITED STATES OF AMERICA:

(Sgd.) Robert Murphy

Note: The Convention became effective upon exchange of ratifications on June 12, 1953.

II. ADMINISTRATIVE REPORT FOR 1959

by the Executive Director
ROY I. JACKSON

This report contains information on administrative and fiscal matters and a record of the activities of the International North Pacific Fisheries Commission and its Secretariat for the period beginning with the close of the Fifth Annual Meeting of the Commission on November 10, 1958, and ending on October 12, 1959, when committee sessions in preparation for the Sixth Annual Meeting began.

1. OFFICERS AND STAFF

Officers of the Commission and its standing committees begin their terms upon adjournment of an annual meeting and continue until adjournment of the subsequent annual meeting. Representation in each of the three offices, Chairman, Vice-Chairman and Secretary, rotates between representatives of the three member countries. Chairman of the Commission for the period which began with the adjournment of the 1958 Annual Meeting was Mr. Edward W. Allen of the United States; the Vice-Chairman was Mr. George R. Clark of Canada; and the Secretary was Mr. Iwao Fujita of Japan. The office of the Chairman of the Standing Committee on Biology and Research was vacant until April 2, 1959, when Mr. Koichiro Kobayashi of Japan, newly-appointed to the Commission, was chosen as Chairman. The Chairman of the Standing Committee on Finance and Administration was Mr. Roger T. Hager of Canada.

With respect to the Secretariat, Miss Anne Waters resigned as Secretary on December 31, 1958 and was replaced by Miss Lorraine Kissack.

2. ACCOUNTS AND AUDIT

The report of the Commission's auditors, Peat, Marwick, Mitchell and Company, for the financial year ended June 30, 1959, is attached to this report as Appendix I.

Each Contracting Party contributed $16,230.00, Canadian funds, toward the operating expenses of the Commission, making a total of $48,690.00 in contributions. In addition, interest earned on the Working Capital Fund, totalling $93.78, was credited to general funds in accordance with Financial Regulation 7.1. Total of funds available was thus $48,783.78. Of this amount, the sum of $3,005.64 was held over into the 1959–60 fiscal period as a reserve for accounts payable, accrued expenses and legal obligations from the 1958–59 fiscal year. These accounts will be received and paid by the end of October and there is, therefore, no surplus from 1958–59 appropriations.

A financial bond in favour of the Commission, in the amount of $25,000.00, was continued on all permanent staff members. The bond is in the hands of the Deputy Minister of Fisheries for Canada for safekeeping.

3. WORKING CAPITAL FUND

The Working Capital Fund, amounting to $5,864.75, Canadian funds, was used once during the fiscal period 1958–59. Delay in receipt of contributions from the member governments and imbalance of expenditures between the first and second halves of the fiscal period necessitated transfer of $2,000.00 from the Working Capital Fund to the general fund on December 24, 1958. The same amount was returned to the Working Capital Fund on January 16, 1959, after second-half contributions had been received. The Executive Director is authorized to make such advances from the Working Capital Fund on the condition that the advances be reimbursed as soon as contributions are received.

4. VOTES

In the interval between the 1958 and 1959 Annual Meetings, the Commission voted by correspondence on various questions. The decisions and the dates on which they were announced or otherwise took effect are as follows:

A. All national sections gave approval to the draft minutes of the third plenary session of the 1958 Annual Meeting. Approval was announced in Circular Letter No. 69, dated January 13, 1959.

B. All national sections gave approval to the draft summary minutes of the *in-camera* session of the Commission, held during the

1958 Annual Meeting. Approval was announced in Circular Letter No. 69, dated January 13, 1959.

C. Mr. Koichiro Kobayashi of Japan was elected as Chairman of the Standing Committee on Biology and Research by unanimous vote of the three national sections. The action was announced in Circular Letter No. 75, dated April 2, 1959.

D. A tentative agenda for the 1959 plenary sessions was circulated to all national sections and accepted, without change, as the provisional agenda for the plenary sessions. The action was announced in Circular Letter No. 93, dated August 25, 1959.

E. It was agreed that a meeting of the scientific sub-committee of the Ad Hoc Committee on Abstention should be held for one week commencing on October 12, 1959, at the Commission's headquarters in Vancouver, B.C. Decision to hold the meeting was announced in Circular Letter No. 97, dated September 8, 1959.

F. All national sections of the Commission approved, for publication, a draft of the Annual Report for 1958. Approval was announced in Circular Letter No. 98, dated September 9, 1959.

G. The Commission approved the issuing of invitations to the following organizations to be represented by observers at the 1959 Annual Meeting of the Commission:

Food and Agriculture Organization of the United Nations

International Pacific Halibut Commission

International Pacific Salmon Fisheries Commission

International Commission for the Northwest Atlantic Fisheries

Inter-American Tropical Tuna Commission.

Union of Soviet Socialist Republics

5. CHANGES IN MEMBERSHIP OF THE NATIONAL SECTIONS

Mr. Kyuhei Suzuki of Japan resigned from the Commission on February 17, 1959, and was succeeded on the same day by Mr. Koichiro Kobayashi. Mr. Kobayashi became Commissioner-member and Chairman of the Standing Committee on Biology and Research, as reported above.

Dr. W. F. Thompson resigned as a member of the Committee on Biology and Research for the United States and was replaced by Dr. W. F. Royce. The notification from the United States National Section was dated August 4, 1959.

6. RESOLUTION ON CONSERVATION

At its 1958 Annual Meeting, the Commission adopted a resolution asking the Contracting Parties to give full consideration to the conservation needs of fisheries resources in the area of common concern when preparing regulations for future operations (Section 3, Minutes of the Third Plenary Session, 1958 Annual Meeting). The resolution was transmitted to the Governments of Canada, Japan and the United States. Replies from these Governments were received and reported to the Commission in Circular Letter No. 82, dated June 12, 1959; Circular Letter No. 85, dated June 29, 1959; and Circular Letter No. 90, dated July 27, 1959.

7. INTERIM MEETINGS

At the 1958 Annual Meeting, the Committee on Biology and Research recommended that an interim meeting be held by a small group of scientists to consider details of research plans for 1959. Circumstances during the year were such that this meeting could not be arranged. Coordination of research plans was carried out by visits of several United States scientists to Japan, frequent contacts between Canadian and United States scientists, and correspondence and consultations by the Secretariat with representatives of all three national sections. A meeting of the scientific sub-committee of the Ad Hoc Committee on Abstention began October 12, in Vancouver, thus becoming continuous in time with the previously-scheduled portions of the 1959 Annual Meeting.

8. NEW HEADOUARTERS

On April 1, 1959, the Secretariat of the Commission moved into spacious, efficient and attractive new offices. The new quarters have been built and made available free of charge by the Government of Canada. They are located in a semi-detached portion of the new Technological Laboratory of the Fisheries Research Board of Canada on the campus of the University of British Columbia, Vancouver, B.C. Most of the office furniture in our previous quarters was the property of the University of British Columbia. It was therefore necessary for the Commission to purchase desks, chairs, tables,

cupboards, files, library shelving, etc., for the new premises.

9. STAFF ACTIVITIES

The Secretariat of the Commission consists of three permanently-employed persons—a Director, Assistant Director and Secretary—and such short-term temporary employees as are required during periods of special activity. In general, the functions of the Secretariat include assisting the Commissioners at meetings, preparing agendas, budgets, reports and other documents for use at meetings, compiling statistics, preparation of the annual report, extensive correspondence and consultation with Commissioners, scientists and Government representatives, etc., in connection with the research program and other basic Treaty obligations, and the continuous exchange of data, samples and scientific, technical and administrative information.

Early in 1959, the volume entitled " Proceedings of the 1958 Annual Meeting " was prepared and distributed to persons designated by each national section. A Japanese-language version of the Proceedings is presently in preparation. This work is done through the courtesy and cooperation of the Japanese National Section, costs being paid by the Commission.

The Japanese-language version of the Annual Report for 1957 has been prepared, printed and distributed, again with the assistance of the Japanese National Section. Line cuts prepared for the English version of each annual report are sent to Japan and used in printing the figures for the Japanese-language version. As this report is written, the English version of the Annual Report for 1958 is being printed. There is some doubt as to whether it can be ready in time for the annual meeting.

During the year, the Secretariat has compiled and reproduced a Statistical Yearbook for 1958, containing catch statistics for the important fisheries of joint interest in the Convention area. Data and tables for the compilation were provided by the statistical agencies of the various countries. In addition, the Secretariat has recompiled and reissued statistical yearbooks for the years 1952 to 1956, inclusive. As a result, statistical yearbooks of comparable form and content are now available for seven years, 1952 to 1958.

In addition to preparing bound volumes of proceedings of the annual meeting, the Secretariat has also prepared and distributed to the appropriate persons three other sets of proceedings. These bring together under single covers the records of the Ad Hoc Committee on Abstention, the Ad Hoc Committee on the Protocol and the records of *in-camera* sessions of the Commission. Arrangements have been made for the reproduction of these compilations in Japanese.

It must again be reported that no scientific bulletins have been issued by the Commission during this period. It is over four years since the last bulletin was published in June, 1955. A total of only six short papers have been submitted for publication to date. The immense scope of the research program and the complexity of the problems involved have delayed production of comprehensive reports. It is urged that effective arrangements be made at the 1959 Annual Meeting for the production of joint and integrated research reports.

Quarterly newsletters have been continued during the current year. The cooperation of the representatives of the various research organizations in providing comprehensive summaries of current research progress is most appreciated.

Since the last annual meeting, members of the staff have made a number of trips in connection with Commission affairs. In February, 1959, the Executive Director travelled to Ottawa and Washington to discuss current and future activities with Commissioners and government representatives. During May, the Executive Director spent slightly over three weeks in Japan, discussing Commission business with members of the Commission and government representatives. Visits were made to many of the scientific institutions concerned with various phases of research for the Commission and the opportunity was taken to view the sailing of the mothership salmon fleet from Hakodate in May.

In June, the Assistant Director made a short trip to San Diego to attend a meeting of the Pacific Section of the American Society of Limnology and Oceanography. A special panel on the interrelations between fisheries and oceanography was of particular interest.

In early June, the Executive Director attended the Tenth Annual Meeting of the International Commission for the Northwest Atlantic Fisheries in Montreal as an observer for this Commission. Advantage was taken of this opportunity to consult with Canadian and United States Commissioners of the North Pacific Commission on current problems. In addition, contact with scientists from the U.S.S.R.

at the ICNAF meeting afforded an opportunity to make further and more definite arrangements for obtaining of salmon samples and scientific information from the U.S.S.R. for use by this Commission. Short trips to San Francisco and Seattle in late June completed the round of consultation with all Commissioners, which had been undertaken by the Executive Director.

In July, the Assistant Director made an inspection trip over portions of the salmon-producing tributaries of the Skeena River system, as a guest of scientists from the Pacific Biological Station of the Fisheries Research Board of Canada. Such visits are most valuable for keeping abreast of current research techniques and problems.

Periodic consultations with the Chairman of the Commission, Mr. Edward W. Allen of Seattle, have aided in conduct of Commission affairs.

Visits to the Pacific Biological Station at Nanaimo, B.C., and the laboratory of the Bureau of Commercial Fisheries in Seattle have been made at fairly frequent intervals for the purpose of discussing progress in Commission research work and to assist in its coordination.

10. APPENDICES

The following reports and documents are submitted to the Commission with this Administrative Report for 1959:

1. Report of the Commission's Auditors (INPFC Doc. 279)
2. Budget Estimates for 1960–61 and Forecast for 1961–62 (INPFC Doc. 282)
3. Statistical Yearbook, 1958
4. Comments on the Form and Nature of the Reports Submitted in 1959 Under Articles III (1) (c) (iii) and X (2) of the Convention (INPFC Doc. 289)
5. Second Report on Penalties for Violations of the Convention (INPFC Doc. 198)

APPENDIX I

PEAT, MARWICK, MITCHELL & CO.
Chartered Accountants
410 Seymour Street
Vancouver 2
B.C.

AUDITORS' REPORT TO THE COMMISSION

We have examined the statement of assets and liabilities of the International North Pacific Fisheries Commission as of June 30, 1959 and the statements of income and expenditure and receipts and disbursements for the year ended on that date and have obtained all the information and explanations we have required. Our examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as we considered necessary in the circumstances.

In our opinion the accompanying statement of assets and liabilities and statements of income and expenditure and receipts and disbursements are properly drawn up so as to exhibit a true and correct view of the state of the affairs of the Commission at June 30, 1959 and the results of its operations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by the books of the Commission.

PEAT, MARWICK, MITCHELL & CO.
Chartered Accountants

Vancouver, B.C.
July 9, 1959.

Statement of Assets and Liabilities
June 30, 1959
(Stated in Canadian Funds)

Assets

General funds:			
Cash in bank			$ 2,580.64
Deposit with United Air Lines			425.00
			3,005.64
Working capital fund:			
Cash in bank			5,864.75
Equipment, at cost		$8,586.18	
Less accumulated depreciation		2,383.04	6,203.14
			$15,073.53

Liabilities

General funds:			
Accounts payable and accrued expenses			$ 3,005.64
Advances from contracting parties for working capital fund			5,864.75
Amount equivalent to expenditure on equipment less depreciation, per contra:			
Amount at June 30, 1958		$5,018.23	
Additions during the year		3,567.95	
		8,586.18	
Deduct:			
Depreciation provided in previous years	$1,524.43		
Depreciation in current year	858.61	2,383.04	6,203.14
			$15,073.53

Statement of Income and Expenditure
Year ended June 30, 1959
(Stated in Canadian Funds)

Income:		
Contributions from contracting parties		$48,690.00
Interest earned on working capital fund bank account		93.78
		48,783.78
Expenditure:		
Personal services	$27,750.45	
Travel	8,162.32	
Transportation of things	495.13	
Communications	1,155.65	
Rent and utilities	1,125.00	
Other contractual services	4,518.73	
Supplies	1,905.36	
Equipment	3,567.95	
Cost of annual meeting	103.19	
		$48,783.78

Status of Appropriations

	Budget Appropriations, Canadian Funds	Appropriations as Modified by Transfers, Canadian Funds	Expenditures
Personal services	$29,600.00	$27,750.45	$27,750.45
Travel	6,500.00	8,162.32	8,162.32
Transportation of things	300.00	495.13	495.13
Communications	1,200.00	1,155.65	1,155.65
Rent and utilities	—	1,125.00	1,125.00
Other contractual services	6,283.78	4,518.73	4,518.73
Supplies	1,500.00	1,905.36	1,905.36
Equipment	2,400.00	3,567.95	3,567.95
Cost of annual meeting	1,000.00	103.19	103.19
	$48,783.78	48,783.78	48,783.78

Note:

The budget appropriation for "other contractual services" has been adjusted to include $93.78 received in interest on the working capital fund.

Statement of Receipts and Disbursements
Year ended June 30, 1959
(Stated in Canadian Funds)

Receipts:		
Contributions from contracting parties		$48,690.00
Interest on working capital fund bank account		93.78
		$48,783.78
Disbursements:		
Personal services	$27,750.45	
Travel	8,113.11	
Transportation of things	495.13	
Communications	1,155.65	
Rent and utilities	1,125.00	
Other contractual services	4,410.69	
Supplies	1,905.36	
Equipment	3,567.95	
Cost of annual meeting	103.19	48.626.53
Excess of receipts over disbursements represented by increase in bank accounts:		
Balance June 30, 1959	8,445.39	
Balance June 30, 1958	8,288.14	
		$ 157.25

III. THE RESEARCH PROGRAM

A. PROGRESS IN 1959 IN CANADIAN RESEARCH ON PROBLEMS RAISED BY THE PROTOCOL

In 1959 Canada continued the following lines of research as part of the Commission's program: (a) high-seas fishing to study salmon distribution and obtain samples for study, (b) studies of parasites of sockeye salmon and of scales of chum salmon to distinguish stocks of various river origins and discover their distribution on the high seas and (c) study of the oceanography of the North Pacific to provide background for understanding salmon distribution and movements. Canada also continued the provision of samples for study by United States and Japan and efforts to recover tags placed on salmon on the high seas.

1. HIGH-SEAS FISHING TO STUDY SALMON DISTRIBUTION AND OBTAIN SAMPLES

Vessel operations and gear. Fishing was carried out by the same vessels as in 1958, namely the *Key West II* and the *Fort Ross*. *The Key West II* left Nanaimo on May 7 and returned from her final cruise on July 27. Corresponding dates for the *Fort Ross* were May 9 and August 11.

The fishing gear used by the *Key West II* consisted of surface gillnets of mesh size $2^1/_2''$, $3^1/_4''$, $4^1/_2''$ and $5^1/_5''$, in the proportion 1:1:3:1, as in 1957 and 1958. The amount of gear set at one time was either 36 or 35 50-fathom shackles.

The *Fort Ross* was engaged in investigating the vertical distribution of salmon. For this purpose she used a gillnet 400 fathoms long (reduced to 350 fathoms after mid-June) and 40 feet deep, of $4^1/_2''$ mesh. This net could be suspended at any one of five depth positions, the series covering the interval from the surface to 200 feet. Additional surface gillnets, similar to those of the *Key West II*, were also carried.

Long-lines and deep-water trolls were carried by both vessels. Plankton nets and mid-water trawls of Isaacs-Kidd pattern were also used.

Collections of salmon for use in the morphometric, parasitological and scale studies of the INPFC program were made by the *Key West II* at seven stations, the localities of which are shown in Figure 1. From 1 to 3 night sets were made at each station between May 18 and June 30. After covering these stations a few sets of long-line and gillnet gear were made by the *Key West II* in waters adjacent to the southern end of the Queen Charlotte Islands.

The locations at which the depth gear was fished by the *Fort Ross* were: 50°N, 135°W; 55°N, 149°W; and an intermediate position which varied to some extent (Fig. 1). These stations were selected to provide different temperature conditions.

Distribution and age of salmon. Catches and accompanying data for surface gillnets fished at the sampling stations are shown in Table I. The relative size of catches of sockeye, pinks and chums, after weighting for the amount of gear and the length of time the gear was fished, is given in Table II. The ages of sockeye and chum salmon are shown in Tables III and IV. These tables supersede the preliminary determinations given in "Progress Report of Canadian Exploratory Fishing for Salmon in the Northeast Pacific in 1959" (INPFC Doc. 292).

Distribution of immature and maturing sockeye and chum salmon in the Gulf of Alaska. Fish caught by Canadian research vessels in 1957, 1958 and 1959 were classified on the basis of weight of gonads in relation to total body weight (percent) and age. A satisfactory division into "immature" and "maturing" categories was obtained by separating the fish which showed higher or lower index values than the following:

Species	Age	Sex	Index value
Sockeye	3_2	Male	0.2
Sockeye	4_2, 5_2, 5_3	Male	0.1
Sockeye	4_2, 5_2, 5_3	Female	1.0
Chum	3, 4	Male	0.1
Chum	3, 4	Female	1.0

Distribution of immature and maturing fish showed a consistent pattern throughout the three years, insofar as the locations and dates of sampling stations permitted comparison. During May and June both categories of sockeye were present through-

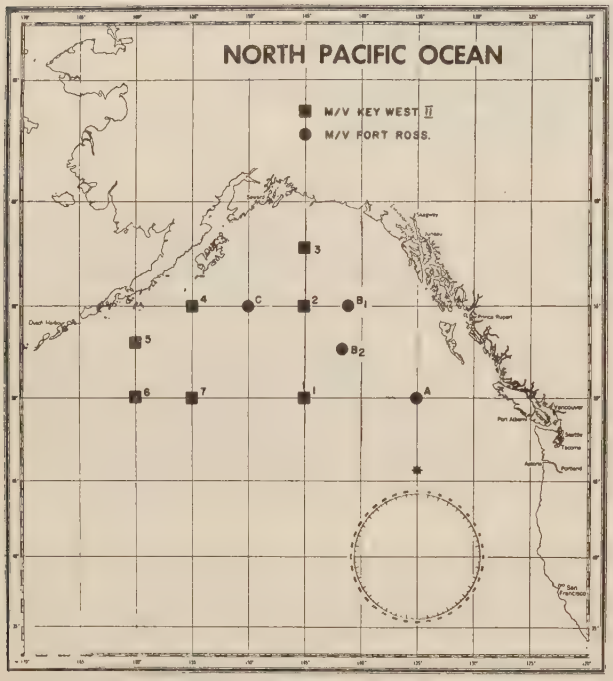


Figure 1. Sampling stations occupied by Canadian research vessels, 1959.

out the Gulf but immature fish were especially prevalent along Latitude 50°N, west of Longitude 145°W, constituting up to 90% of the sockeye caught in this area. They constituted a much smaller proportion of catches made at stations closer to land. In July and August maturing fish were virtually absent from catches made west of Longitude 145°W. Chum salmon showed a generally similar pattern but some maturing fish continued to occur in western areas until a later date than sockeye. The area near Latitude 50°N, west of Longitude 145°W appears to be an important feeding area for immature fish of both species.

Vertical distribution of salmon. In the investigations of the vertical distribution of salmon, the sunken net was fished in conjunction with a surface gillnet similar to those used in ordinary sampling operations but consisting of only 6 shackles. The catches made by each kind of gear are recorded in Table V. Relative numbers of sockeyes, pinks and chums caught at different depths, by time periods, are shown in Figure 2 and Table VI. These comparisons are limited to fish caught at

Table I. Salmon catches by the *Key West II*, 1959.

Date	Position		No. of shackles	Surf. temp. (°C)	Salmon				
	Lat. (°N)	Long. (°W)			Sockeye	Pink	Chum	Coho	Total
May 18	50°00′	145°00′	36	7.9	46	9	19	—	74
19	50°00′	145°00′	36	7.9	58	29	6	8	101
21	55°00′	145°00′	36	7.0	130	7	30	—	167
22	55°00′	145°00′	36	6.5	26	—	6	—	32
23	55°00′	145°00′	36	6.8	156	2	9	—	167
25	58°00′	145°00′	36	7.9	190	—	27	—	217
26	58°00′	145°00′	?	8.6	13	—	3	—	16
June 10	54°56′	155°00′	36	8.1	105	5	26	—	136
12	55°11′	155°00′	36	8.9	363	14	163	—	540
14	53°00′	160°00′	36	8.1	14	76	27	—	117
24	53°00′	160°00′	35	9.6	41	46	11	—	98
25	53°00′	160°00′	35	9.4	104	148	60	—	312
27	50°00′	160°00′	35	9.9	91	54	239	—	384
28	50.00′	160°00′	35	10.0	129	89	—	—	218
29	50°00′	155°00′	35	10.4	217	16	137	3	373
July 17	51°00′	130°15′	35	13.8	11	—	—	—	11
18	51°00′	132°00′	35	13.5	4	—	—	—	4
19	52°10′	131°24′	35	12.9	8	16	—	—	24
24	52°00′	134°00′	35	13.1	3	—	—	—	3
25	51°00′	132°00′	35	13.1	40	2	1	—	43
Total					1749	513	764	11	3037
Percent					57.6	16.9	25.1	0.4	100.0

Table II. Relative abundance of salmon. Catches are weighted to 900 fathoms of surface gillnet fishing 10 hours, each mesh size equally represented.

Station	Position Lat. (°N)	Long. (°W)	No. of sets	Weighted catch Sockeye	Pink	Chum
1	50	145	2	14	6	3
2	55	145	3	31	1	5
3	58	145	1	48	—	9
4	55	155	2	100	3	43
5	53	160	3	28	21	9
6	50	160	2	41	16	30
7	50	155	1	240	6	57

night, since the number of daytime sets was small. It is possible that diurnal vertical movements by the fish may complicate the picture.

In May, sockeye and chum salmon were caught at each of the five depth intervals but sockeye were more frequent in the top 40 feet and chums below 80 feet. Later in the season all sockeye and pinks and most of the chums were taken within 40 feet of the surface. The balance of the chums was between 40 and 80 feet. The apparent change in vertical distribution during the course of the season coincided with the development of a thermocline below the level at which fish were caught (Fig. 2).

Table III. Age composition of sockeye salmon catches in the northeast Pacific, 1959, excluding catches by *Key West* during July 17-25.

Date	Stn.	Age 3_2	4_2	4_3	5_2	5_3	5_4	6_2	6_3	6_4	7_4	Unknown	Total
						Key West II							
May 18-19	1	11	47	1	18	15	—	1	5	—	—	6	104
21-23	2	8	44	2	43	23	—	—	22	2	3	20	167
25-26	3	1	68	—	61	39	—	1	20	4	3	6	203
June 10-12	4	16	108	3	22	56	1	—	16	4	2	35	263
14-25	5	42	30	8	18	34	—	—	13	4	—	10	159
27-28	6	69	21	24	3	11	1	—	1	1	—	10	141
29	7	126	10	7	—	5	—	—	—	—	—	13	161
Total		273	328	45	165	183	2	2	77	15	8	100	1198
						Fort Ross							
May 17-20	B	7	13	—	32	8	—	2	10	1	—	3	76
26-28	C	—	10	—	3	6	—	—	3	—	—	1	23
June 10-12	C	—	12	—	4	10	—	—	1	—	—	—	27
July 5-11	A	—	8	—	7	2	—	—	1	3	—	1	22
15-21	B	1	16	—	2	1	—	1	—	—	—	—	21
25-Aug 1	C	5	8	4	—	4	—	—	—	1	—	2	24
Total		13	67	4	48	31	—	3	15	5	—	7	193

Table IV. Ages of chum salmon caught at Canadian sampling stations, 1959.

Date	Station	Age 2	3	4	5	Unknown	Total
May 18-19	1	1	16	3	0	5	25
21-23	2	0	11	34	0	0	45
25-26	3	0	4	21	4	1	30
Jun 10-12	4	0	74	67	2	46	189
14-25	5	1	59	26	0	12	98
27-28	6	0	62	95	4	78	239
29	7	0	75	29	1	32	137
Total		2	301	275	11	174	763

Plankton. Plankton samples taken in conjunction with fishing operations have not yet been thoroughly examined. As in 1958, the chaetognath *Sagitta lyra*, which is tentatively regarded as an indicator of warm water intrusion and possibly of conditions less favourable for feeding salmon, was widespread in the eastern part of the Gulf of Alaska.

2. STUDY OF SOCKEYE SALMON PARASITES TO DISTINGUISH STOCKS

During the past year the studies commenced in 1955 on the use of parasites of sockeye salmon (*Oncorhynchus nerka*) as a means of tracing the ocean distribution of North American and Asian

Table V. Salmon catches by the M/V *Fort Ross*, 1959.

Date		Position Lat. (°N)	Position Long. (°W)	No. hrs. fished	Surface temp. (°C)	Surface gill-net Sockeye	Pink	Chum	Coho	Total	Sunken gill-net Depth	Sockeye	Pink	Chum	Coho	Total
May	13[1]	50°00′	135°00′	8.0	8.5	—	—	—	—	—	0′– 40′	—	—	—	—	—
	17	55°00′	141°00′	8.5	6.4	6	—	3	—	9	0′– 40′	6	—	—	—	6
	17[1]	55°00′	141°00′	7.0	6.8	2	—	—	—	2	0′– 40′	1	—	—	—	1
	18	55°00′	141°00′	8.0	6.4	17	—	—	—	17	40′– 80′	2	—	—	—	2
	18[1]	55°00′	141°00′	7.0	6.6	5	—	—	—	5	40′– 80′	—	—	—	—	—
	19	55°00′	141°00′	9.0	—	15	1	—	—	16	80′–120′	—	—	5	—	5
	19[1]	55°00′	141°00′	6.0	6.8	2	—	—	—	2	80′–120′	2	—	—	—	2
	20	55°00′	141°00′	10.0	6.4	1	—	2	—	3	120′–160′	—	—	3	—	3
	20[1]	55°00′	141°00′	6.0	7.0	6	—	3	—	9	120′–160′	1	—	1	—	2
	21	55°00′	141°00′	8.0	6.6	22	—	21	—	43	160′–200′	1	—	2	—	3
	25	55°00′	150°00′	8.5	6.2	——not fished——					0′– 40′	4	2	1	—	7
	25[1]	55°00′	150°00′	7.5	6.8	——not fished——					0′– 40′	—	—	—	—	—
	26	55°00′	150°00′	8.5	6.5	7	1	1	—	9	40′– 80′	1	2	2	—	5
	26[1]	55°00′	150°00′	8.0	7.5	2	—	1	—	3	40′– 80′	1	—	6	—	7
	27	55°03′	149°54′	13.5	—	7	—	—	—	7	80′–120′	3	—	2	—	5
	28	55°03′	149°54′	8.0	6.6	7	—	—	—	7	120′–160′	—	—	—	—	—
	28[1]	55°03′	149°54′	5.0	7.2	—	—	1	—	1	120′–160′	5	—	1	—	6
June	10	55°39′	150°23′	9.0	8.8	13	—	4	—	17	0′– 40′	16	2	1	1	20
	11	55°39′	150°23′	9.0	9.1	6	4	—	1	11	40′– 80′	3	6	1	—	10
	12	55°39′	150°23′	7.0	9.6	8	1	—	—	9	80′–120′	—	1	—	—	1
	13	55°39′	150°23′	—	9.5					——nets tangled——						
July	5	50°00′	135°00′	8.0	11.6	—	—	—	—	—	0′– 40′[2]	6	1	—	—	7
	6	50°00′	135°00′	8.5	11.8	2	—	—	—	2	40′– 80′	—	—	—	1	1
	7	50°00′	135°00′	8.5	12.0	4	—	—	—	4	80′–120′	—	—	—	—	—
	10	50°00′	135°00′	9.0	11.8	5	1	—	1	7	120′–160′	—	—	—	—	—
	11	50°00′	135°00′	9.5	12.0	11	—	—	—	11	160′–200′	—	—	—	—	—
	15	52°30′	142°00′	8.0	9.7	6	6	7	—	19	0′– 40′	3	11	6	—	20
	18	52°30′	142°00′	8.0	10.8	3	2	1	—	6	40′– 80′	—	—	2	—	2
	19	52°30′	142°00′	8.5	11.0	9	3	2	—	14	80′–120′	—	—	—	—	—
	20	52°30′	142°00′	8.5	11.1	1	1	6	—	8	120′–160′	—	—	—	—	—
	21	52°30′	142°00′	8.5	11.0	2	3	5	—	10	160′–200′	—	—	—	—	—
	25	54°10′	150°30′	8.0	10.7	10	3	2	—	15	0′– 40′	13	14	24	1	52
	26	54°10′	150°30′	8.0	10.8	11	3	27	—	41	80′–120′	—	—	—	—	—
Aug	1	54°30′	150°37′	8.0	11.2	3	1	1	—	5	40′– 80′	—	—	6	—	6
	2	54°30′	150°30′	20.0	11.1	——species unidentified——				5	160′–200′	——tangled; no catch——				
Total						193	30	87	2	312		68	39	63	3	173

[1] Daytime set.

[2] Length of net reduced from 400 fathoms to 350 fathoms from this date.

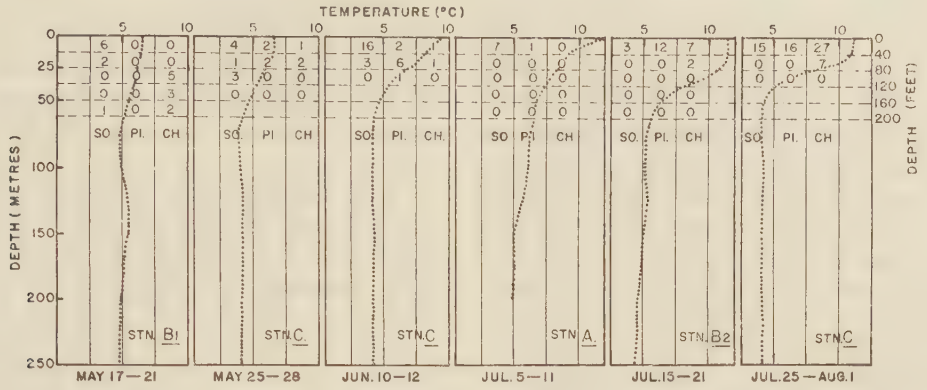


Figure 2. Average temperature profiles (dotted lines) at fishing stations with salmon catches (weighted) at various depths.

stocks of these fish were continued and expanded. Progress in the research for the years 1955 to 1957 has been reported in the Annual Reports for 1956, 1957 and 1958. The last report contained a review of the pertinent data for the three years during which the studies had been in progress.

In the Annual Report for 1958 four parasites were reported as providing evidence of the origin of sockeye taken on the high seas. Two of these were *Triaenophorus crassus*, a cestode found only in some western Alaska (mainly Bristol Bay) sockeye stocks, and *Dacnitis truttae*, a nematode found in some sockeye of Asian origin, both of which are parasites acquired in fresh water before the young sockeye migrate to sea. Once the fish take up their ocean residence further acquisition of these parasites becomes impossible. Since these parasites have a restricted geographical distribution in sockeye stocks they serve to identify the geographical origin of ocean-caught sockeye infected with them.

The other two parasites, *Tubulovesicula lindbergi* and *Hemiurus levinseni*, are trematodes acquired in the sea. *Tubulovesicula* was considered to indicate North American origin of sockeye infected with this species because of the characteristics of the distribution of sockeye infected with it and because it never occurred together with *Dacnitis* or *Hermiurus* in the same fish but was present in some sockeye simultaneously infected with *Triaenophorus*. The occurrence of *Hermiurus* in high-seas samples of sockeye, other than from the Gulf of Alaska, was suggested as indicating the Asian origin of such fish because of the characteristics of the distribution of sockeye infected with it and because it never occurred along with *Triaenophorus* or *Tubulovesicula* in the same fish,

Table VI. Relative numbers of sockeye, pink and chum salmon at various depth intervals to 200 feet. Data are based on sunken net catches at night weighted to 400 fathoms of gear.

Date	No. sets	Depth (ft)	Sockeye Av. catch per set	Sockeye %	Pink Av. catch per set	Pink %	Chum Av. catch per set	Chum %
May–June	3	0– 40	8.7	68.4	1.3	30.3	0.7	10.1
	3	40– 80	2.0	15.8	2.7	62.6	1.0	14.5
	3	80–120	1.0	7.9	0.3	7.1	1.7	24.6
	2	120–160	0.0	0.0	0.0	0.0	1.5	21.8
	1	160–200	1.0	7.9	0.0	0.0	2.0	29.0
Total			12.7	100.0	4.3	100.0	6.9	100.0
July–Aug.	3	0– 40	8.3	100.0	9.6	100.0	11.4	79.0
	3	40– 80	0.0	0.0	0.0	0.0	3.0	21.0
	3	80–120	0.0	0.0	0.0	0.0	—	0.0
	2	120–160	0.0	0.0	0.0	0.0	—	0.0
	2	160–200	0.0	0.0	0.0	0.0	—	0.0
Total			8.3	100.0	9.6	100.0	14.4	100.0

but was found in some fish also parasitized with *Dacnitis*.

Although in 1958 the distribution of fish infected with *Tubulovesicula* or *Hemiurus* fitted the general pattern of previous years, one sockeye was encountered which was infected simultaneously with *Hemiurus* and *Triaenophorus*, and another carried both *Hemiurus* and *Tubulovesicula*. The sockeye infected with *Triaenophorus* and *Hemiurus* was a maturing female, age 4_2, taken in the Bering Sea at 56°N, 172°30′W, and the sockeye infected with *Hemiurus* and *Tubulovesicula* was an immature male, age 4_3, taken south of the Aleutians at 50°N, 180°.

Triaenophorus indicates western Alaskan origin of any sockeye infected with it and therefore the occurrence of *Hemiurus* along with *Triaenophorus* in a maturing sockeye demonstrates that *Hemiurus* may be found in sockeye which are migrating to western Alaska. Consequently it can no longer be stated that every high-seas sockeye carrying *Hemiurus* (exclusive of those in the Gulf of Alaska) is of Asiatic origin. However, since we have rarely observed *Hemiurus* in sockeye samples taken near the shores or the mouths of rivers of western Alaska it is probably true that most ocean-caught sockeye infected with *Hemiurus* (except those in the Gulf of Alaska) are of Asiatic origin.

The occurrence of *Hemiurus* and *Tubulovesicula* in the same fish also conflicts with the use of these parasites in identifying the continent of origin of individual sockeye taken on the high seas. Although *Tubulovesicula* generally is associated with sockeye of North American origin, the suggestion that it is never found in sockeye of Asiatic origin may be doubtful, since the origin of the fish harbouring both *Hemiurus* and *Tubulovesicula* is unknown.

Since the parasites were used to identify the origin of individual fish it is apparent from the foregoing that neither *Hemiurus* nor *Tubulovesicula* can be considered to be completely reliable indicators. Some revision of previously presented conclusions (see Annual Report for 1958) on the distribution of sockeye stocks from North America and Asia are therefore necessary. The ensuing discussion on ocean distribution of sockeye from North America and Asia will be based only on the distribution of sockeye infected with *Triaenophorus* and *Dacnitis* and is applicable only within the limits of time and locations of the sampling.

Of all North American sockeye stocks, the ocean distribution of those from some western Alaskan rivers only can be traced with certainty, since it is in this region alone that *Triaenophorus* occurs in sockeye.

The Asiatic rivers in which the sockeye are infected with *Dacnitis* are not well known because of the lack of samples from Asian rivers. However, A. K. Akhmerov, in papers published in 1954 and 1955, recorded *Dacnitis* from Kamchatka River sockeye, and since we have consistently found *Dacnitis* in some of the sockeye from the Sea of Okhotsk (off the southwest tip of Kamchatka) it would appear that *Dacnitis* also occurs in sockeye from one or more rivers on the west coast of Kamchatka. *Dacnitis* therefore gives evidence of ocean distribution of some sockeye originating from both east and west Kamchatka.

In the laboratory 3,323 sockeye were examined from collections made in 1958, compared to a combined total of 4,610 for the three previous years, 1955 to 1957, inclusive. The 1958 samples consisted of 331 seaward migrants (smolts) from North America, 614 adults from coastal North America and 2,378 sockeye from the high seas. The high-seas samples, collected from mid-May to the latter half of August, included immature (fish which would have spent at least one more year at sea before returning to spawn) and maturing fish (fish which would have spawned in the year they were caught). The localities from which samples were collected, the date of each collection and the number of sockeye examined from each collection site are given in Tables VII to IX. Figure 3 also shows the distribution of coastal adult and high-seas sockeye samples.

A. High-seas distribution of North American and Asiatic sockeye in 1958 as determined by *Triaenophorus* and *Dacnitis*. In shore samples of adults from North America *Triaenophorus* was most prevalent in the Wood River (Nushagak River system) and was also found, but to a much lesser extent, in the Naknek River, both of which empty into Bristol Bay. It was also found in the seaward migrants from these two systems. *Triaenophorus* was not found in any other North American samples listed in Tables VII and VIII. In addition to the above two rivers, *Triaenophorus* was observed in previous years in one smolt from the Ugashik River, Bristol Bay and in one adult returning to spawn in the Kuskokwim River, on the west coast of Alaska, north of Bristol Bay.

Table VII. Locality, data of catch, and size of sockeye smolt samples examined for parasites from 1958 collections from North America.

Locality	Date of catch	Number of sockeyes
Baker R., Washington	20–VI	13
Cultus Lake, Fraser R., British Columbia	20–IV	25
Seton Creek, Fraser R., British Columbia	5 to 12–V	25
Chilko R., Fraser R., British Columbia	1–V	25
Babine Lake, Skeena R., British Columbia	7–VI	25
Sockeye Creek, Ketchikan, southeast Alaska		40
Karluk R., Kodiak Is., Alaska	24–VI	25
Chignik R., Alaska Peninsula	11–VI	25
Ugashik R., Bristol Bay, Alaska	27, 28–V	25
Brooks R., Bristol Bay, Alaska	25, 26, 27, 29–VI and 3–VII	28
Naknek R., Bristol Bay, Alaska	29–V	25
Kvichak R., Bristol Bay, Alaska	21, 22–V	25
Wood R., Bristol Bay, Alaska	31–V	25
Total		331

Table VIII. Locality, date of catch, and size of adult sockeye samples examined for parasites from 1958 collections from coastal North America. (The letters preceding the locality refer to the lettered positions in Fig. 3).

	Locality	Date of catch	Number of sockeyes
A.	Columbia R. (Astoria, Oregon)	22 to 28–VI	23
B.	Fraser R., British Columbia	6–VIII	25
	Fraser R., British Columbia	8–IX	25
C.	Rivers Inlet, British Columbia	13, 14–VII	25
D.	Skeena R., British Columbia	31–VII, 1–VIII	25
E.	Nass R., British Columbia	8–VII	25
F.	Naha Bay (Ketchikan), southeast Alaska	17–VII	25
G.	Stikine R. (Petersburg), southeast Alaska	9–VII	25
H.	Situk-Ahrnklin R. (Yakutat), Alaska	21–VII	25
I.	Eyak R. (Cordova), central Alaska	21–VII	25
J.	Seldovia, Cook Inlet, Alaska	14–VII	25
K.	Karluk R., Kodiak Is., Alaska	26–VI	25
	Karluk R., Kodiak Is., Alaska	31–VIII	24
L.	Red R., Kodiak Is., Alaska	24–VI	25
M.	Chignik, Alaska Peninsula	1–VII	25
N.	Shumagin Is., Alaska Peninsula	10–VII	25
O.	Ugashik R., Bristol Bay, Alaska	16–VII	25
P.	Egegik R., Bristol Bay, Alaska	7–VII	25
Q.	Naknek R., Bristol Bay, Alaska	9–VII	25
	Naknek R., Bristol Bay, Alaska	19–VII	27
R.	Kvichak R., Bristol Bay, Alaska	10–VII	25
S.	Wood R., Bristol Bay, Alaska	4–VII	25
T.	Togiak R., Bristol Bay, Alaska	12, 13–VII	25
U.	Kuskokwim R., northwestern Alaska	2, 4–VII	15
V.	Salmon Lake, northwestern Alaska	27–VII	25
	Total		614

Table IX. Locality, date of catch and size of high-seas sockeye samples examined for parasites from 1958 collections. (The numbers preceding the locality refer to the numbered positions in Fig. 3).

	Locality	Date of catch	Number of sockeyes
(1)	50°49′ N, 153°07′ E	5–VII	25
(2)	51°09′ N, 153°40′ E	25–VI	25
(3)	51°08′ N, 153°45′ E	15–VI	25
(4)	51°39′ N, 154°10′ E	15–VII	25
(5)	48°55′ N, 156°28′ E	5–VII	53
(6)	50°35′ N, 159°50′ E	19–VII	49
(7)	51°58′ N, 159°51′ E	26–VII	55
(8)	49°21′ N, 160°27′ E	16–VI	55
(9)	54° N, 163° E	2–VI	5
(10)	55°02′ N, 164°02′ E	4–VI	10
(11)	55° N, 164° E	7–VIII	50
(12)	55° N, 164° E	29–VII	50
(13)	56°01′ N, 164°58′ E	30–VI	5
(14)	58° N, 166° E	25–VI	6
	58° N, 166° E	26–VI	8
	58°02′ N, 166°03′ E	22–VI	4
(15)	49°35′ N, 166°35′ E	25–VI	54
(16)	59°01.5′ N, 167° E	21–VI	18
(17)	50°41′ N, 167°14′ E	15–VI	51
(18)	50°10′ N, 168°15′ E	16–V	54
(19)	59°16.5′ N, 169°03′ E	17–VI	20
(20)	47°30′ N, 169°41′ E	26–V	55
(21)	59°18′ N, 170°38′ E	31–VII	95
(22)	59°20′ N, 170°51′ E	13–VI	5
	59°28′ N, 170°54′ E	12–VI	3
	59°27′ N, 171°04′ E	11–VI	5
(23)	51°05′ N, 171°30′ E	29–V	53
(24)	52°02′ N, 171°35′ E	5–VI	53
(25)	53° N, 172° E	2–VI	12
(26)	50°50′ N, 172°30′ E	7–VI	55
(27)	51°35′ N, 173° E	8–VI	10
(28)	49°21′ N, 173°19′ E	16–V	54
(29)	54° N, 173° E	1–VI	17
(30)	55° N, 174° E	31–V	5
(31)	53°21′ N, 174°58′ E	22–VII	2
	54° N, 174°58′ E	21–VII	3
	55°01′ N, 174°58′ E	20–VII	2
	55°59′ N, 175°01′ E	19–VII	5
(32)	49° N, 175° E	15–VII	10
(33)	50° N, 175° E	16–VII	14
(34)	52° N, 175° E	18–VII	49
	53° N, 175° E	19–VII	3
(35)	54° N, 175° E	17–VII	6
	55° N, 175° E	18–VII	16
	54°02′ N, 176°28′ E	16–VII	2
(36)	50°37′ N, 175°02′ E	8–VI	11
(37)	49°39′ N, 176°11′ E	14–VII	4
	50°18′ N, 177°28′ E	13–VII	8
(38)	54° N, 178° E	15–VII	17
(39)	50°59′ N, 178°50′ E	12–VII	49
(40)	48°33′ N, 178°29′ E	1–VI	3
	49° N, 180°	31–V	7
	50°03′ N, 180°	29–V	8
	51° N, 180°	28–V	8
(41)	50° N, 180°	30–VI	42
(42)	53° N, 178°15′ E	29–V	5
	53° N, 180°	28–V	6
(43)	54°43′ N, 178°14′ E	22–VI	9
	53° N, 180°	17–VI	3
	54° N, 180°	18–VI	11
(44)	53°31′ N, 180°	14–VII	26
(45)	52°04′ N, 178°38′ W	12–VII	14
(46)	54° N, 178° W	10–VI	11
(47)	52°58′ N, 175°13′ W	27–VII	7
(48)	49°30′ N, 175° W	8–VII	4
	50°30′ N, 175° W	7–VII	15
	51°17′ N, 175°53′ W	6–VII	24
	50°22′ N, 177°45′ W	10–VII	5
(49)	53°01′ N, 175° W	2–VII	7
(50)	53° N, 174°59′ W	5–VIII	7
(51)	55° N, 175° W	7–VIII	13
(52)	51°30′ N, 175° W	5–VIII	53
(53)	50° N, 175° W	6–VIII	77
(54)	49° N, 175° W	7–VIII	27
(55)	56° N, 172°30′ W	18–VI	50
(56)	53°30′ N, 170°02′ W	17–VI	54
(57)	55°58′ N, 170°04′ W	26–VI	23
(58)	56°57′ N, 168°58′ W	27–VI	2
(59)	57°59′ N, 169°59′ W	28–VI	2
(60)	51° N, 170° W	11–VIII	52
(61)	50° N, 170° W	10–VIII	29
(62)	49° N, 170° W	9–VIII	11
(63)	55°04′ N, 169°24′ W	25–VI	79
(64)	52°51′ N, 166° W	15–VIII	24
(65)	52° N, 165° W	17–VIII	29
(66)	51° N, 165° W	18–VIII	27
(67)	50° N, 165° W	19–VIII	27
(68)	55° N, 155° W	15–VI	72
(69)	50° N, 155° W	25–VI	25
(70)	55° N, 150° W	7–VI	54
(71)	58° N, 145° W	4–VI	50
(72)	55° N, 145° W	1–VI	25
(73)	50° N, 145° W	24–V	25
(74)	55° N, 135° W	15–VI	16
(75)	55° N, 135° W	15–VIII	15
(76)	51° N, 130° W	8–VIII	25
	Total		2378

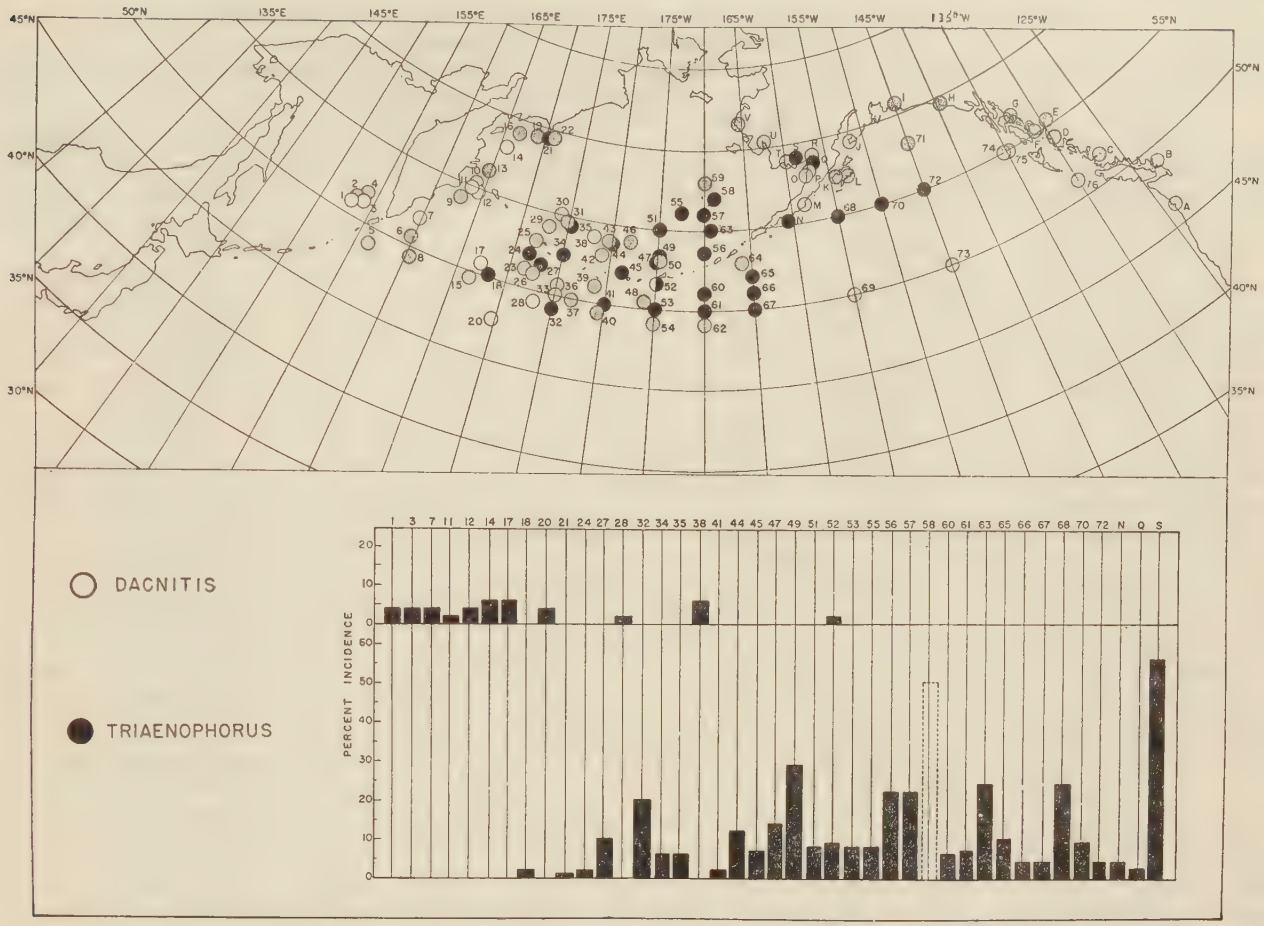


Figure 3. Distribution of sockeye salmon samples examined in 1958 and the occurrence and incidence of *Triaenophorus* and *Dacnitis* in these samples. (Stippled circles denote samples containing neither *Triaenophorus* or *Dacnitis*).

Shore samples from Asia were again unavailable but some samples taken close to the east coast of Kamchatka and some from the Sea of Okhotsk off the southwest coast of Kamchatka showed the presence of *Dacnitis*. It was not observed in any of the North American samples listed in Tables VII and VIII.

Figure 3 shows the distribution of sockeye (exclusive of seaward migrants) infected with *Triaenophorus* or *Dacnitis*. From this figure it is apparent that sockeye of western Alaskan origin (i.e. infected with *Triaenophorus*), mainly from Bristol Bay, were found as far west as 168°15′E and sockeye of Asiatic origin (i.e. infected with *Dacnitis*) were found as far east as 175°W. Since *Triaenophorus* and *Dacnitis* occur in only part of the sockeye originating in North America and Asia, respectively, and because of sampling limitations, the range of ocean distribution of sockeye from the two continents may be greater than indicated by these two parasites.

Table X lists the localities at which sockeye infected with *Triaenophorus* or *Dacnitis* were found, the date of catch, the number of fish examined at each locality, the number and percent of fish infected with *Triaenophorus* or *Dacnitis*, the age of these fish and whether they were maturing or immature. The determination of the state of maturity was based largely on the gonad development and utilized the gonad weight to body weight ratio, as proposed by Mr. H. Godfrey of the Fisheries Research Board's Biological Station at Nanaimo. In a few cases in which the gonad weight had not been recorded, the decision as to probable state of maturity was based on age, size of the fish, locality and date of catch.

Distribution of maturing sockeye. The upper chart in Figure 4 shows the distribution of maturing sockeye which harboured *Triaenophorus*

TAble X. Incidence of *Triaenophorus* and *Dacnitis* in 1958 sockeye samples, with age and stage of maturity of the infected fish.

Locality	Date	Number examined	Infected with *Triaenophorus* No.	%	Infected with *Dacnitis* No.	%	Age[a]	Maturity[b]
Wood R., Bristol Bay	4-VII	25	14	56	—	—	$4_2(10),5_3,5_2,?(2)$	m
" " " "	31-V	25	9	36	—	—	—	smolts
Naknek R., Bristol Bay	9, 19-VI	52	1	2	—	—	5_3	m
" " " "	29-V	25	1	4	—	—	—	smolts
55° N, 145° W	1-VI	25	1	4	—	—	4_2	m
55° N, 150° W	7-VI	54	5	9	—	—	$4_2(4),5_3$	m
55° N, 155° W	15-VI	72	17	24	—	—	$4_2(15),5_3,5_2$	m
Shumagin Is., Alaska	10-VII	25	1	4	—	—	5_3	m
50° N, 165° W	19-VIII	27	1	4	—	—	5_3	i
51° N, 165° W	18-VIII	27	1	4	—	—	4_2	i
52° N, 165° W	17-VIII	29	3	10	—	—	$4_2(2),5_3$	i
56°57′ N, 168°58′ W	27-VI	2	1	(50)	—	—	4_2	m
55°04′ N, 169°24′ W	25-VI	79	19	24	—	—	$4_2(9),5_3(3),5_2$	m
							2 oc. (5),?(1)	
50° N, 170° W	10-VIII	29	2	7	—	—	4_2,?(1)	i
51° N, 170° W	11-VIII	52	3	6	—	—	$4_2,5_3$,?(1)	i
53°30′ N, 170°02′ W	17-VI	54	12	22	—	—	$4_2(4),5_3(2),5_2(5),6_3$	m
55°58′ N, 170°04′ W	26-VI	23	5	22	—	—	$4_2(3),5_3(2)$	m
56° N, 172°30′ W	18-VI	50	4	8	—	—	$4_2,5_3,5_2,6_3$	m
50° N, 175° W	6-VIII	77	6	8	—	—	$3_2,4_3,5_4,4_2,5_3(2)$	i
51°30′ N, 175° W	5-VIII	53	5	9	1	2	Triaen. $3_2,4_2$,2 oc.(2)	i
							Triaen. 4_2	m
							Dacnit. 3_2	i
53°01′ N, 175° W	2-VII	7	2	29	—	—	5_3	m
							2 oc.	i
55° N, 175° W	7-VIII	13	1	8	—	—	4_2	i
52°58′ N, 175°13′ W	27-VII	7	1	14	—	—	4_2	i
52°04′ N, 178°38′ W	12-VII	14	1	7	—	—	1 oc.	i
50° N, 180°	30-VI	42	1	2	—	—	4_3	i
53°31′ N, 180°	14-VII	26	3	12	—	—	$4_3,5_4,4_2$	i
54° N, 178° E	15-VII	17	—	—	1	6	3_2	i
49° N, 175° E	15-VII	10	2	20	—	—	$3_2,4_3$	i
52° N, 175° E	18-VII	49	3	6	—	—	$4_3(2),?(1)$	i
55° N, 175° E	18-VII	16	1	6	—	—	3_2	i
49°21′ N, 173°19′ E	16-V	54	—	—	1	2	5_2	m
51°35′ N, 173° E	8-VI	10	1	10	—	—	7_3	m
52°02′ N, 171°35′ E	5-VI	53	1	2	—	—	6_3	m
59°18′ N, 170°38′ E	31-VII	95	1	1	—	—	5_3	i
47°30′ N, 169°41′ E	26-V	55	—	—	2	4	$5_2,6_2$	m
50°10′ N, 168°15′ E	16-V	54	1	2	—	—	5_2	m
50°41′ N, 167°14′ E	15-VI	51	—	—	3	6	$5_2,6_2$?(1)	m
58° N, 166° E	22, 25, 26-VI	18	—	—	1	6	6_2	m
55° N, 164° E	29-VII	50	—	—	2	4	$4_2(2)$	i
55° N, 164° E	7-VIII	50	—	—	1	2	4_2	i
51°58′ N, 159°51′ E	26-VII	55	—	—	2	4	5_2	m
51°08′ N, 153°45′ E	15-VI	25	—	—	1	4	6_3	m
50°49′ N, 153°07′ E	5-VII	25	—	—	1	4	6_3	m

a—Numbers in parentheses following the age indicate the number of fish of that age. Where there is no number following an age it signifies that only one fish of that age was encountered. Sockeyes for which the age could not be determined, either because of poor scales, are indicated by? Where the freshwater zone of a scale could not be interpreted the ocean growth is indicated by the number of years followed by oc.

b—Fish which would have matured in the year they were caught are indicated by " m " and those that would have remained in the ocean at least one more year, i.e. immatures, are indicated by " i ".

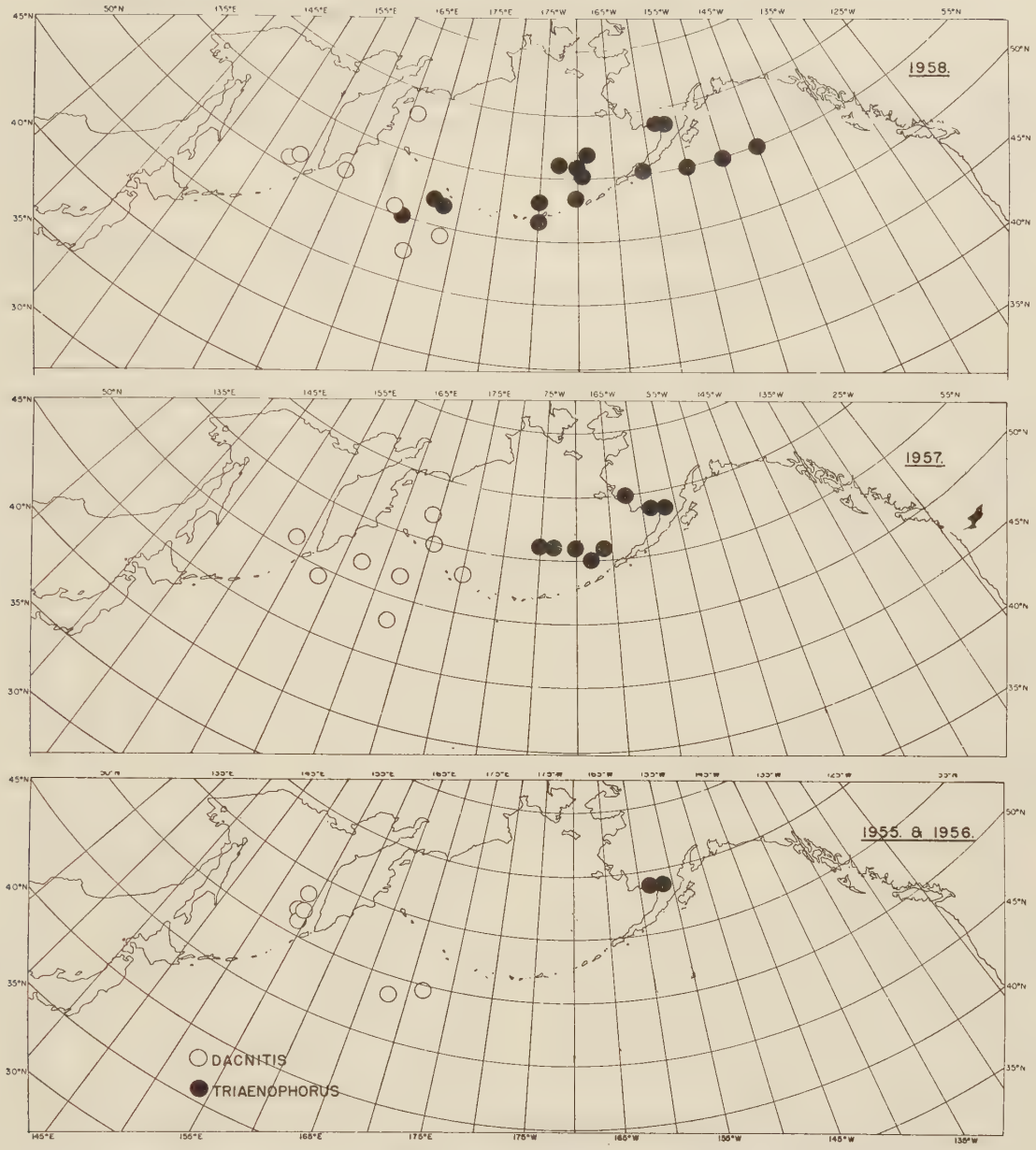


Figure 4. Distribution of maturing sockeye salmon infected with *Triaenophorus* or *Dacnitis* in the years 1955 to 1958.

or *Dacnitis* in 1958. *Triaenophorus*-infected maturing sockeye were found as far west as 168°15′E and eastward into the Gulf of Alaska to 145°W. *Dacnitis*-infected maturing sockeye were found from the Sea of Okhotsk eastward to 173°19′E.

The maturing sockeye infected with *Dacnitis* were caught from mid-May to the end of July, the earliest-caught fish generally having been taken farther to the east. The maturing sockeye infected with *Triaenophorus* (not including those taken in or near the estuaries of the home streams) were, with three exceptions, caught in May or June (see Table X). The three exceptions were: (1) one fish taken on July 10 in the commercial fishery operating in the Shumagin Islands area, Alaska, (2) one fish taken on July 2 at 53°01′N, 175°W and (3) one fish taken on August 5 at 51°30′N, 175°W. The occurrence of a maturing western Alaska sockeye in mid-ocean as late as August 5 seems very unusual, because it is generally believed that the sockeye returning to spawn in western Alaska have entered

Table XI. Incidence of *Triaenophorus* in adult sockeye runs to Bristol Bay in 1958, based on samples from each river.

River	Size of "run" (catch+escapement)	Sample size	% infected with *Triaenophorus*	Estimated no. infected in total "run"
Nushagak (Wood)	2,000,000	25	56	1,120,000
Kvichak	1,200,000	25	0	0
Naknek	575,000	52	2	11,500
Egegik	750,000	25	0	0
Ugashik	700,000	25	0	0
Totals	5,225,000			1,131,500

Estimated incidence of *Triaenophorus* in total Bristol Bay run – 21.7%

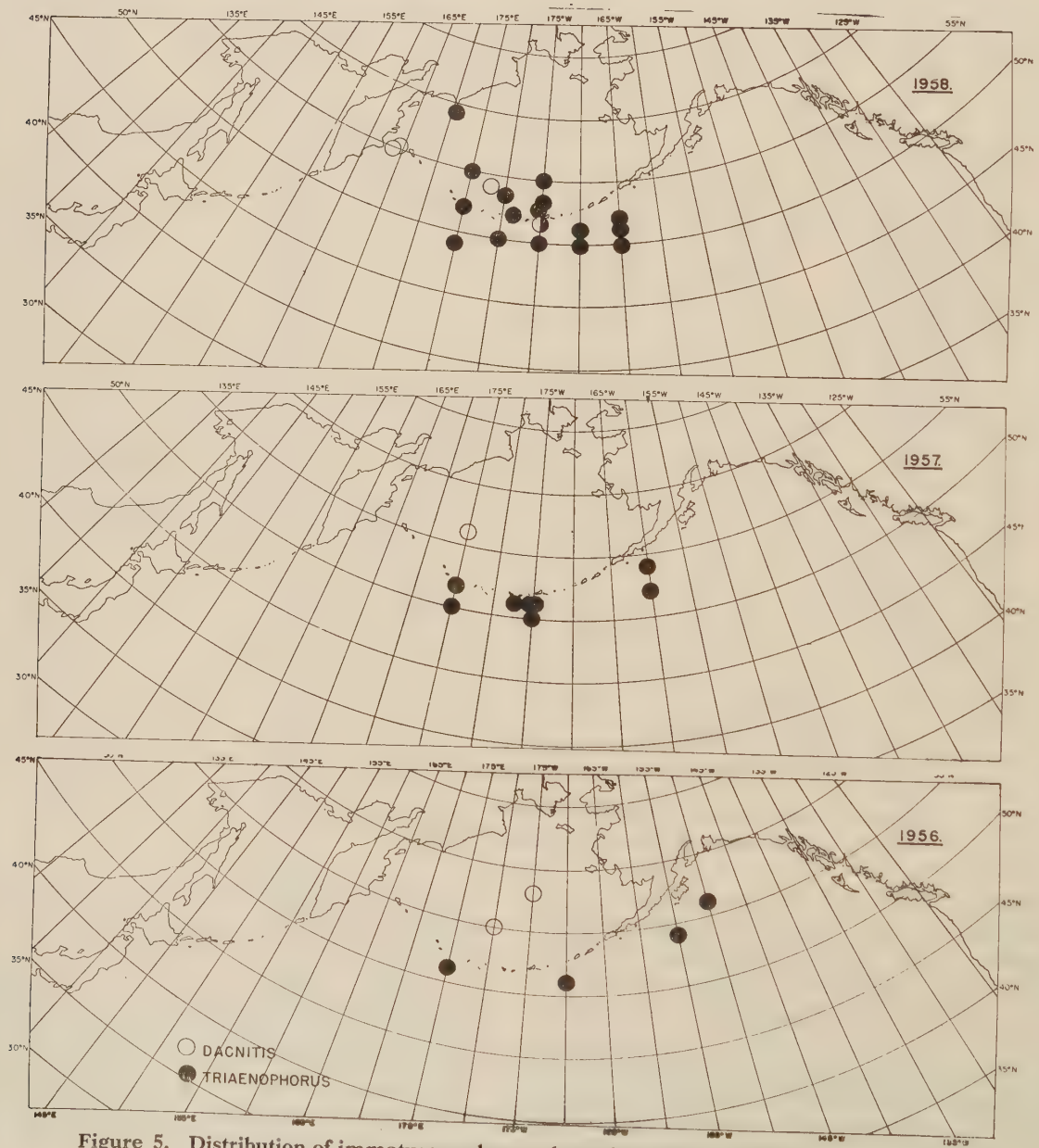


Figure 5. Distribution of immature sockeye salmon infected with *Triaenophorus* or *Dacnitis* in the years 1956 to 1958.

Table XII. Incidence of *Triaenophorus* in adult sockeye runs to Bristol Bay in 1957, based on samples from each river

River	Size of "run" (catch+escapement)	Sample size	% infected with *Triaenophorus*	Estimated no. infected in total "run"
Nushagak (Wood)	1,000,000	25	20	200,000
Kvichak	6,500,000	20	0	0
Naknek	1,500,000	25	12	180,000
Egegik	1,150,000	20	0	0
Ugashik	575,000	20	0	0
Totals	10,725,000			380,000
Estimated incidence of *Triaenophorus* in total Bristol Bay run – 3.5%				

the rivers by the end of July or early August, but on the basis of gonad weight this sockeye definitely seems to be maturing. The fish was a female, age 4_2, with a body weight of 2,140 grams and a gonad weight of 88 grams. All other sockeye taken in the latter half of July or throughout the month of August, not only in 1958 but in other years as well, which were identified as being of western Alaskan origin because of the presence of *Triaenophorus*, were immatures. It appears that most of the maturing western Alaska sockeye leave the open ocean by the end of June, but some may remain there until early August.

The majority of maturing *Triaenophorus*-infected sockeye captured west of their area of origin (western Alaska) were from the Bering Sea between 175°W and 169°W, and were taken almost exclusively in the second half of June. The three *Triaenophorus*-infected sockeye from the area bounded by 168°E and 173°E Longitude and 50°N and 52°N Latitude were captured in May or early June. The apparent absence of *Triaenophorus*-infected sockeye between 173°E and 175°W may well be due to the fact that few samples taken from this area in May or June were examined. In the Gulf of Alaska the maturing *Triaenophorus*-infected sockeye were all taken in the first half of June.

Some features of the incidence of *Triaenophorus* in maturing sockeye were extremely interesting. On the basis of the small samples examined from the spawning runs to the rivers of Bristol Bay an overall incidence of *Triaenophorus* in all Bristol Bay sockeye (catch plus escapement) was calculated to be almost 22% (see Table XI). In the samples examined from 55°04′N, 169°24′W (79 sockeye), 53°30′N, 170°02′W (54 sockeye), 55°58′N, 170°02′W (23 sockeye) in the Bering Sea, and from 55°N, 155°W (72 sockeye) in the Gulf of Alaska, the incidence of *Triaenophorus* was either 22% or 24% (see Table X), which is identical or almost identical with the calculated overall percent incidence for Bristol Bay. This suggests that the samples from these high-seas localities consisted wholly or largely of a mixture of Bristol Bay sockeye, the various stocks being present in proportion to the size of their respective spawning runs.

In the Gulf of Alaska at 55°N, 150°W and at 55°N, 145°W the incidence of *Triaenophorus*-infected sockeye decreased to 9% and 4% respectively, and at 55°N, 135°W none were found, indicating a progressive decrease towards the east in the number of Bristol Bay sockeye in the samples. In the samples from 58°N, 145°W, 50°N, 145°W, and 50°N, 155°W *Triaenophorus* was not found.

Only one good sample was obtained from 170° to 175°E and therefore no data are available on the trends of *Triaenophorus* infection of sockeye in this area. In the 50 sockeye from 56°N, 172°30′W, the incidence of *Triaenophorus* was 8%. This lower rate of *Triaenophorus* infection as compared to the samples taken at 169°W and 170°W could mean that the sample did not consist solely of Bristol Bay sockeye, or that the various Bristol Bay stocks were not represented in proportion to the size of their respective runs, or that a greater proportion of uninfected than infected sockeye were represented from the stocks in which *Triaenophorus* occurred.

In the samples from south of the Aleutians between 173°E and 168°E only 3 maturing sockeye out of approximately 300 examined were found infected with *Triaenophorus*, suggesting a much lower proportion of Bristol Bay sockeye than in the samples from near 169°W and 170°W in the Bering Sea. Since good samples were also available to the west of 168°E and *Triaenophorus* was not found, 168°E probably was close to the extreme western limit of Bristol Bay or western Alaska sock-

eye, at least for the period during which the samples were collected.

Distribution of immature sockeye. The upper chart in Figure 5 shows the distribution of immature sockeye infected with *Dacnitis* or *Triaenophorus*.

Few *Dacnitis*-infected immature sockeye were found in the samples. One was taken just south of the Aleutian Islands at 175°W on August 5 in a sample which also contained several sockeye infected with *Triaenophorus*. Another was taken in the Bering Sea at 54°N, 178°E on July 15 and three were taken off the east coast of Kamchatka at 55°N, 164°E on July 29 or August 7.

Immature sockeye infected with *Triaenophorus* were represented in many of the samples from 165°W to 175°E which were collected from June 30 to August 19. One was also encountered in a sample of 95 fish from 59°18′N, 170°38′E taken on July 31, 1959. Most of the immature *Triaenophorus*-infected sockeye were taken south of the Aleutians, but some were also found in samples from north of the Aleutians to 55°N between 175°W and 175°E.

B. **Comparison of high-seas distribution of sockeye in 1958 with earlier years (1955–1957).** Figure 4 shows the distribution of maturing sockeye infected with *Dacnitis* or *Triaenophorus* for the years 1955 to 1958, inclusive.

One feature in the distribution of *Dacnitis*-infected maturing sockeye which is more or less similar from year to year is the most easterly point of capture, which is between 172°E and 175°E Longitude. It is impossible to determine if there was any change in the distribution of *Dacnitis*-infected sockeye from year to year because of their low incidence (never more than 11 in any one year and only 1.6% to 4% of all maturing sockeye taken from 175°E to the Sea of Okhotsk) and because the sampling locations, dates of sampling and the number of samples were not the same from year to year. For example, in the Bering Sea region in 1957 *Dacnitis* was found at 54°51′N, 170°24′E, and 57°02′N, 169°11′E. Samples from these locations were not examined in other years.

For between-year comparisons of the distribution of maturing *Triaenophorus*-infected sockeye, only 1957 and 1958 can be considered satisfactorily because of the lack or scarcity of samples in 1955 and 1956 from east of 175°E during the months of May and June.

In 1957 the qualitative distribution of *Triaenophorus*-infected maturing sockeye in the Bering Sea from 175°W and eastward was similar to that in 1958, but the incidence in this area was considerably less. Of the 263 fish examined from 166°W to 175°W, 3.4% were infected with *Triaenophorus* (incidence varying from 0% to 12% in individual samples) which is close to the calculated *Triaenophorus* incidence of 3.5% for all Bristol Bay runs combined, in 1957 (see Table XII). The much lower overall rate of *Triaenophorus* infection in the Bristol Bay stocks in 1957 as compared to 1958 is therefore reflected in the incidence in Bering Sea samples. This lower incidence was due to two factors: (1) The Wood River (Nushagak River system), which provides the majority of *Triaenophorus*-infected sockeye, comprised only about 10% of the 1957 Bristol Bay run, compared to about 40% in 1958, and (2) the incidence of *Triaenophorus* in the 1957 Wood River run was apparently lower than in 1958.

The samples from the Gulf of Alaska in 1957 were taken later in the season than those from comparable locations in 1958 (see 1958 Annual Report). If maturing Bristol Bay sockeye had been present in the Gulf of Alaska in 1957 they probably would have left the area on their homeward migration prior to commencement of the sampling. Therefore the absence of maturing sockeye infected with *Triaenophorus* from the Gulf of Alaska samples in 1957 may not indicate a real difference between 1957 and 1958.

Also, the failure to record any *Triaenophorus*-infected maturing sockeye in 1957 as far west as in 1958 cannot be interpreted as indicating that western Alaskan sockeye extended farther to the west in the latter year. In 1958, when the overall incidence of *Triaenophorus* in Bristol Bay sockeye was considerably higher (about 6 times) than in 1957, only 1% of the 300 sockeye examined in samples collected in May or early June between 168°E and 173°E were infected. This is about 1/20 of the overall incidence for Bristol Bay for that year. If the same relative representation of infected sockeye had prevailed in this area in 1957, then only about 0.17% would have been expected to be infected with *Triaenophorus*. Less than 100 maturing sockeye, taken in May or early June, from 175°E to 168°E were examined and the absence of *Triaenophorus* from these samples cannot lead to any conclusions regarding the presence or absence of Bristol Bay sockeye in this area in 1957.

Figure 5 shows the distribution of immature

sockeye infected with *Dacnitis* or *Triaenophorus* in the samples examined in the years 1956 to 1958.

Since few *Dacnitis*-infected immature sockeye have been observed in the samples there are insufficient data for a comparison between years. The most easterly records have been at 175°W in 1956 and 1958.

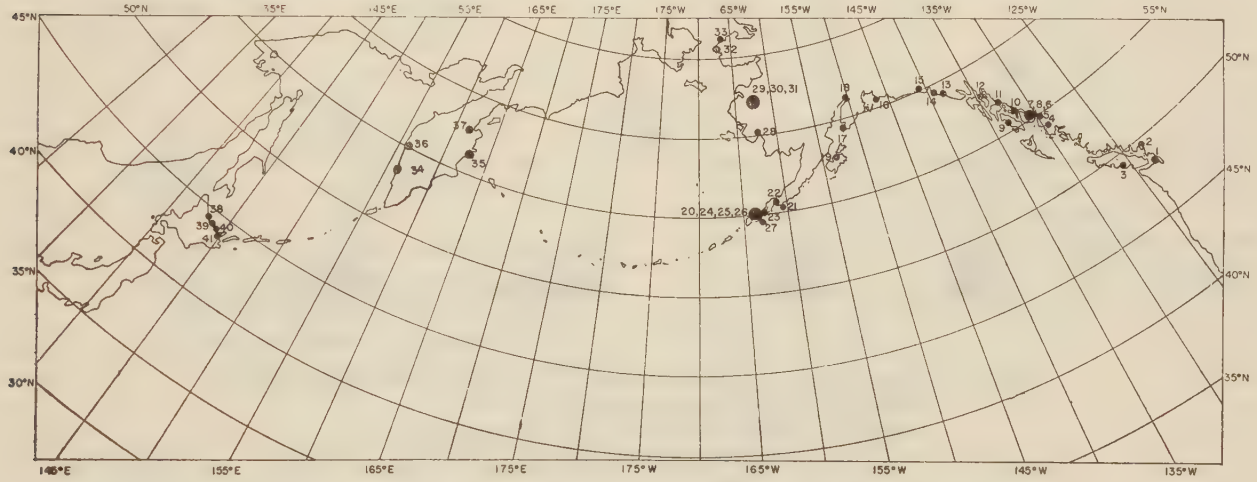
A constant feature of the distribution of immature sockeye infected with *Triaenophorus* is their occurrence south of the Aleutians to 175°E. The increased number of these immature sockeye observed from 1956 to 1958 is attributable in part to the increase in numbers of fish examined, but there was also an increase in the incidence of *Triaenophorus* in the immatures examined from samples taken from 175°E to 160°W. In 1956 1.5% of about 200 fish were infected, in 1957 3.3% of about 400 fish and in 1958 5% of about 600 fish.

Whether or not the occurrence of immature sockeye infected with *Triaenophorus* in the Bering Sea in 1958 indicates a real difference from other years cannot be determined because of differences in the number of fish examined and their localities and dates of capture.

3. STUDY OF CHUM SALMON SCALES TO DISTINGUISH STOCKS

In 1959, Canadian studies of chum salmon scales to distinguish stocks involved examination of scales collected in 1957 from coastal areas and spawning grounds throughout the North Pacific area. Scales from 3,576 chums from 33 inlets or river systems in North America and from 8 Asian river systems in Siberia and Japan were examined. The sampling areas and numbers of specimens examined from each are shown in Figure 6.

Age composition (Table XIII). In 1957,



Map No.	Location	No. in sample	Map No.	Location	No. in sample	Map No.	Location	No. in sample
1	Puget Sound	52	16	Cordova, Prince William Sound	58	30	Yukon River, Alakanuk	40
2	Fraser River	161	17	Seldovia, Rocky Bay	101	31	Yukon River, Far North	244
3	W. Coast Vanc. Isl.	100	18	Cook Inlet, Kalgen Island	102	32	Teller, Pt. Clarence	87
4	Skeena River	146	19	Uyak Bay	71	33	Kotzebue Sound	38
5	Nass River	114	20	Larsen Bay	150	34	Bolshaya River	49
6	Portland Canal	44	21	Shumigan Island	249	35	Kamchatka River	49
7	Boca de Quadra	12	22	Pavlof Bay	105	36	Icha River	47
8	Boca de Quadra, Anan Bay	76	23	Cold Bay	267	37	Uka River	25
9	Noyes Island	11	24	False Pass	51	38	Yubetsu River	33
10	Anan Bay	37	25	Unimak Island	7	39	Tokoro River	59
11	Farragut Bay	25	26	Alitak	167	40	Abashiri River	162
12	Seymour Canal	73	27	King Cove	150	41	Shari River	92
13	Pt. Eaton	19	28	Kuskokwim River	73			
14	Yakutat, East River	82	29	Yukon River, Old Andreafsky	104			
15	Taku River	44						

Figure 6. Sampling locations for chum salmon utilized for 1957 scale studies.

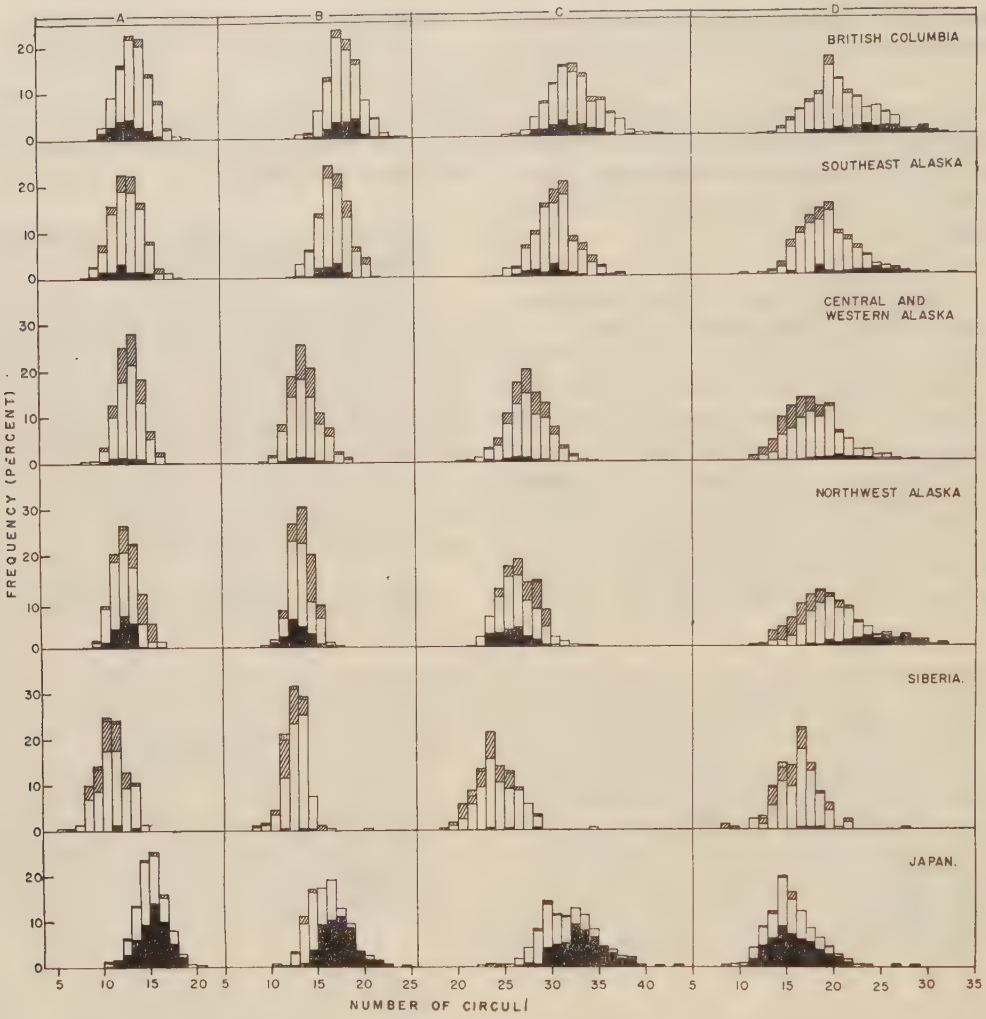


Figure 7. Distribution of circulus counts for scales of chum salmon from different areas of the North Pacific in 1957.
Column A—Circuli in first half of first-year band.
Column B—Circuli in last half of first-year band.
Column C—Total first-year circuli.
Column D—Total second-year circuli.
Black bars indicate frequencies for 3_1 fish, white for 4_1's and cross-hatched for 5_1's.

Table XIII. Percent age composition of chum salmon sampled in 1957 from 6 general areas.

Area	Age 3_1	4_1	5_1	6_1	7_1
British Columbia	18.2	75.7	6.1	—	—
Southeast Alaska	10.6	75.7	13.7	—	—
Central and Western Alaska	6.2	68.1	25.6	.1	—
Northwest Alaska	19.3	55.7	24.2	.8	—
Siberia	1.7	71.8	23.6	2.3	.6
Japan	51.7	45.4	2.9	—	—

chum salmon from the inshore waters of North America were again predominantly 4-year-olds, but the proportion of 3- and 5-year-olds was somewhat higher than in 1956. Siberian chums were also mainly 4-year-olds (70%). This is in contrast with data for 1956 when samples of chums taken off the Siberian coast contained roughly equal proportions of 4- and 5-year-old fish as well as a substantial number of 3-year-olds. Chums sampled in Japanese streams in 1957 were also mainly 4-year-olds but 3-year-olds were also well represented.

Circulus counts (Fig. 7). The 1956 data indi-

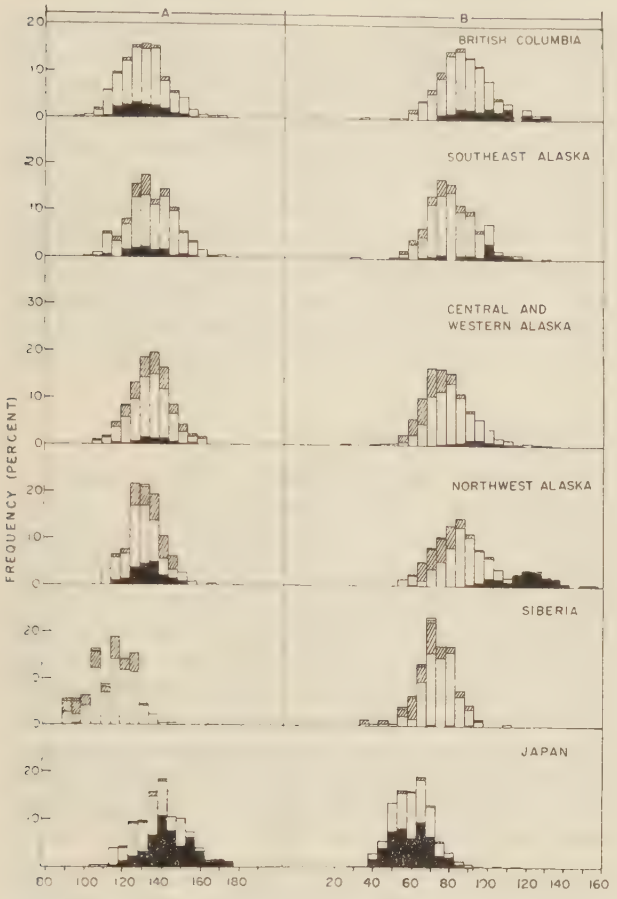


Figure 8. Widths of first- and second-year bands of scales of chum salmon from different areas of the North Pacific in 1957.

Column A—First-year annulus widths
Column B—Second-year annulus widths

cated a geographical cline in the number of **circuli in the first-year band,** fish from the southern extremes of the range tending to have more circuli than those from the more northern areas. The 1957 data show essentially the same trend. As seen in Figure 7, British Columbia (including State of Washington) and southeast Alaska chums had many closely packed circuli, more or less evenly distributed throughout the first-year band. Chums from the northwest part of North America (central, western and northwest Alaska) had fewer circuli, especially in the last half of the first-year band. Chums from Siberia had the fewest circuli of all. Japanese chums again exhibited a higher first-year circulus count, quite similar in magnitude to chums from British Columbia.

There was also a cline in the number of **circuli in the second-year band,** with the number of second-year circuli decreasing from East to West. Chums from British Columbia had the highest second-year circuli counts, whereas Japanese chums had the lowest (see Fig. 7).

Table XIV. Percentage of chums from 6 general areas having first-year annulus widths of 1.05 mm or less.

Area	Percentage
British Columbia	2.61
Southeast Alaska	1.19
Central and Western Alaska	1.09
Northwest Alaska	0
Siberia	34.70
Japan	.58

Table XV. Percentage of chums from 6 general areas having total first-year circulus counts of 30 and more.

Area	Percentage
British Columbia	92.85
Southeast Alaska	78.72
Central and Western Alaska	26.89
Northwest Alaska	12.67
Siberia	.59
Japan	84.39

Table XVI. Proportion of chums from 6 general areas having first-year circulus counts of 30 and more and a difference of 0.45 mm or less between first- and second-year annulus widths.

Area	Percentage of sample
British Columbia	57.6
Southeast Alaska	27.2
Central and Western Alaska	5.7
Northwest Alaska	1.9
Siberia	0
Japan	0.6

Circulus counts for the first year for each area were quite similar for all age groups. Second-year counts, however, tended to vary with age, with the younger fish tending to have higher counts than the older ones (this tendency was evident for all stocks except the Japanese ones).

Annulus measurements (Fig. 8). Differences in annulus measurements between stocks tended

to parallel the observed differences in circulus counts. First-year annuli in the southern-most extremes of the chum salmon's range (i.e. British Columbia and Japan) tended to be larger than those in the northern areas. For second year annuli, however, there was an East-West cline in annulus widths; scales from British Columbia chums had the largest second-year widths, while those from Japanese chums had the smallest.

Some distinguishing characteristics of Asian and North American chums. As seen in Figure 8, Siberian chum salmon tended to have narrower first-year annuli than did chums from other areas. Fish with first-year annuli measuring 1.05 mm and less composed 35% of the samples collected from Siberian streams, whereas they formed less than 3% of the fish sampled in other areas. The percentage of fish having first-year annulus measurements of 1.05 mm and less for each of the six general areas of study are listed in Table XIV.

As noted in Figure 7, fish having first-year circulus counts of 30 and more formed the major proportion of samples from British Columbian, southeast Alaskan and Japanese coastal areas. Only one fish of the 170 sampled from Siberia exhibited a circulus count as high as 30 (Table XV). It can also be seen from Figure 7 that although fish from Japan had high first-year circulus counts similar to those for British Columbian and southeast Alaskan fish, they had considerably lower second-year circulus counts and annulus widths. On the basis of these observations, for fish from each of the six general areas, a comparison was made of the difference between the first-year and second-year annulus widths for fish with 30 and more circuli in the first year. It was found (Table XVI) that chums having 30 and more first-year circuli and differences between the widths of the first and second annuli of 0.45 mm and less formed over half of the fish sampled in British Columbia, approximately one-quarter of the southeast Alaskan fish, less than 10% of the fish sampled in the more northern North American streams and virtually none of the fish from the Asian samples (only 2 out of 516 fish examined).

4. OCEANOGRAPHY

A. **North Pacific surveys.** Two oceanographic surveys co-ordinated with the research program of the Commission were accomplished this year. The first, a winter survey, was carried out between January 20 and February 15 aboard C.N.A.V. *Oshawa* north of Latitude 47°N and east of Longitude 157°W. The second, a summer survey, was carried out during the period August 4 to September 1. Two ships, C.N.A.V. *Oshawa* and C.N.A.V. *Whitethroat*, were used and they covered the area north of Latitude 38°N and east of Longitude 160°W to the North American coast. Observations at Ocean Weather Station "P" (Latitude 50°N, Longitude 145°W) were continued, with sections at six-week intervals between that point and the coast.

January—February, 1959. The observed temperature distribution at 10 metres depth (a more

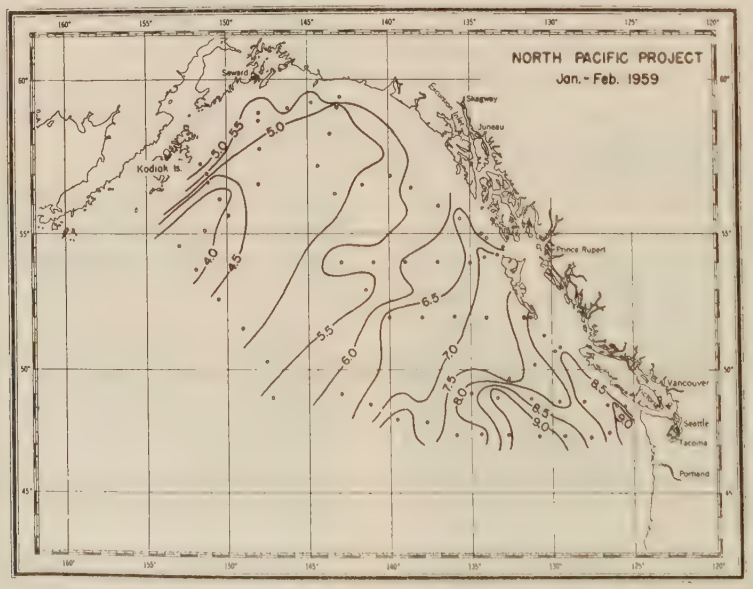


Figure 9. Temperature (°C.) at 10 meters, Jan.–Feb. 1959.

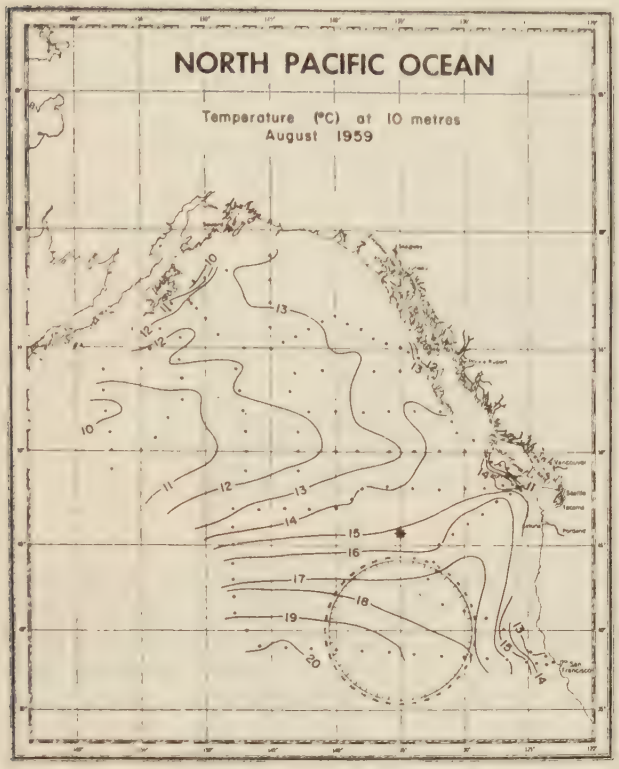


Figure 10. Temperature (°C.) at 10 meters, August 1959.

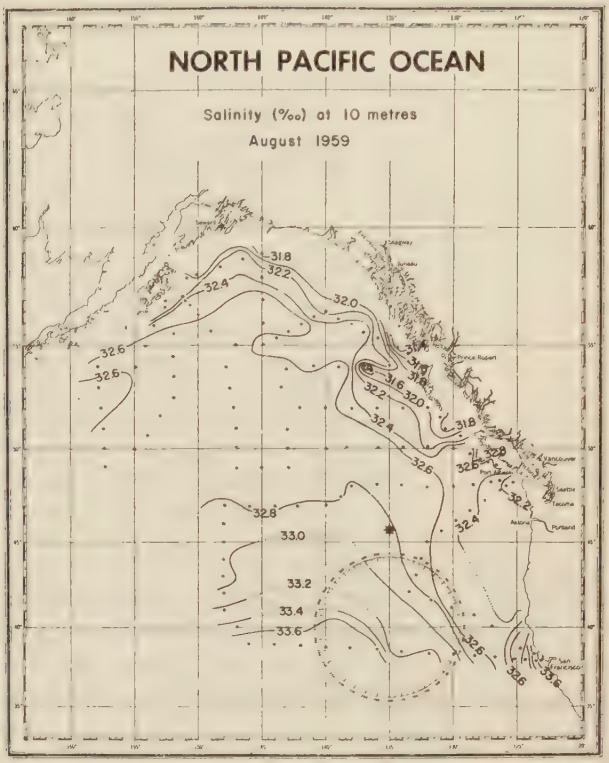


Figure 11. Salinity (‰) at 10 meters, August 1959.

Figure 12. Temperature (°C.) on the surface, August 1959.

realistic level than the surface) is shown in Figure 9. Temperatures in the Alaska Gyral and mid-ocean region were practically the same as in March—April, 1958. However, around the coast the water was about one degree (°C) colder than in the previous winter, but still warmer than the average. These data, however, do not represent the winter minimum, which occurred in late March, as shown by the data from Ocean Station " P " (Lat. 50°N, Long. 145°W).

The salinity distribution at 10 metres depth was similar to that observed during the previous winter. The high salinity centre (<32.8‰) south of Kodiak Island, which was absent during the previous summer, was again present. As usual, there was a band of low salinity water close along shore, all around the coast. At 100 metres depth high salinity (<33.4‰) was present off Vancouver Island and southeast of Kodiak Island. The cells of low salinity water, observed during the previous summer, had dissipated at the time of this survey.

August, 1959. The temperature distribution at 10 metres depth (Fig. 10) was similar to that observed during August, 1956. Between Ocean Station " P " and the coast the water was considerably cooler (3°C) than during August, 1958 and some-

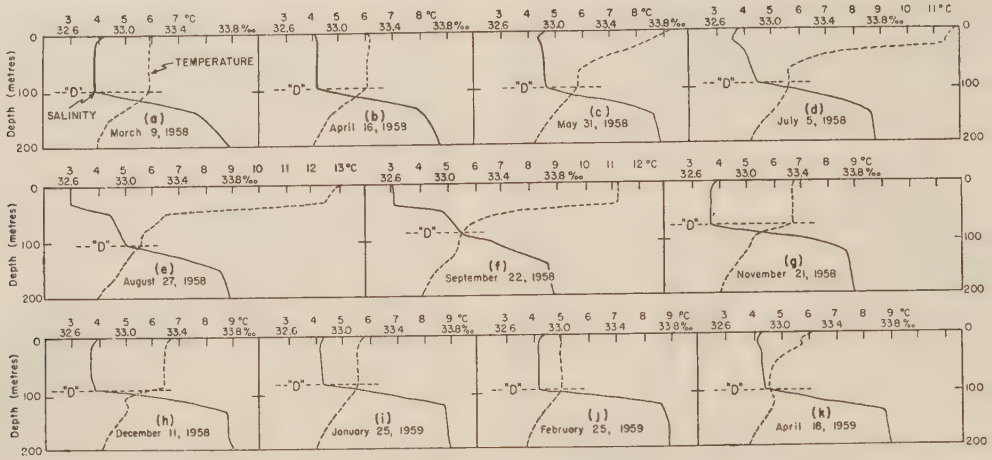


Figure 13. Salinity (—) and temperature (– –) structure at Ocean Station " P " (lat. 50°N, long. 145°W), March 1958–April 1959.

what cooler than during August, 1957. Similar conditions existed at the surface at Ocean Station " P " during this period. Immediately off the coast of Vancouver Island temperatures were relatively cold, being similar to those observed during the previous summer.

The salinity distribution (Fig. 11), unlike the temperature distribution at 10 metres depth, was more similar to that observed during the summers 1957 and 1958 than that observed during the summer 1956. However, the 32.6‰ isohaline did not extend as far offshore as observed during the two previous periods.

The salinity and temperature distributions suggest " upwelling " off the coast of Vancouver Island and the California coast.

The warm water intrusion. The distribution of temperature on the surface σ_t=26.60 (density 1.02660) has been used in earlier reports to show the intrusion of warm water below the level of seasonal influence since 1956 (see Fig. 20, Annual Report for 1958). The distribution of temperature on this surface for August, 1959, is shown in Figure 12. This temperature distribution was very similar to that observed during August, 1956, particularly off the British Columbia coast.

B. **Depth of seasonal influence in the sub-Arctic Pacific Ocean.** Previous reports have shown that the salinity structure, with minor variations, is a permanent feature of the eastern sub-Arctic and this structure could be accurately delineated by plotting salinity as a function of the logarithm of the depth. Such a plot leads to a definition of three distinct zones; an upper zone of relatively homogeneous low salinity water, a transition zone characterized by a marked halocline, and a lower zone in which the salinity increases gradually with depth. These are separated by two marked discontinuities at the upper and lower limit of the halocline. They have been designated " D " and " L " respectively.

A study of the upper zone now has been completed on all available data for the sub-Arctic region of the North Pacific Ocean for the periods 1956 through 1959. As a result it can now be shown that an upper zone, and a limit " D ", can be defined throughout the sub-Arctic region. The lower limit " L ", however, is not an invariable feature of this region. In areas of mixing such as the vicinity of the Aleutian Islands and in some areas of the Bering Sea the marked halocline deepens and the lower limit " L " becomes indefinite. It has also been shown that in the western sub-Arctic, when the lower limit of the halocline can be defined, the salinity at " L " approximates 33.8‰, very near the values that have been reported previously for the eastern sub-Arctic.

It is now apparent from an examination of data at Ocean Station " P " (Fig. 13) that the upper zone is established during the period of cooling, and although it undergoes changes, it can be defined throughout the period of heating, April—September, and is again re-established during the winter period when surface cooling and mixing by either wind action or convection, or both, produces isohaline and isothermal structures to " D ". These processes do not extend below " D ".

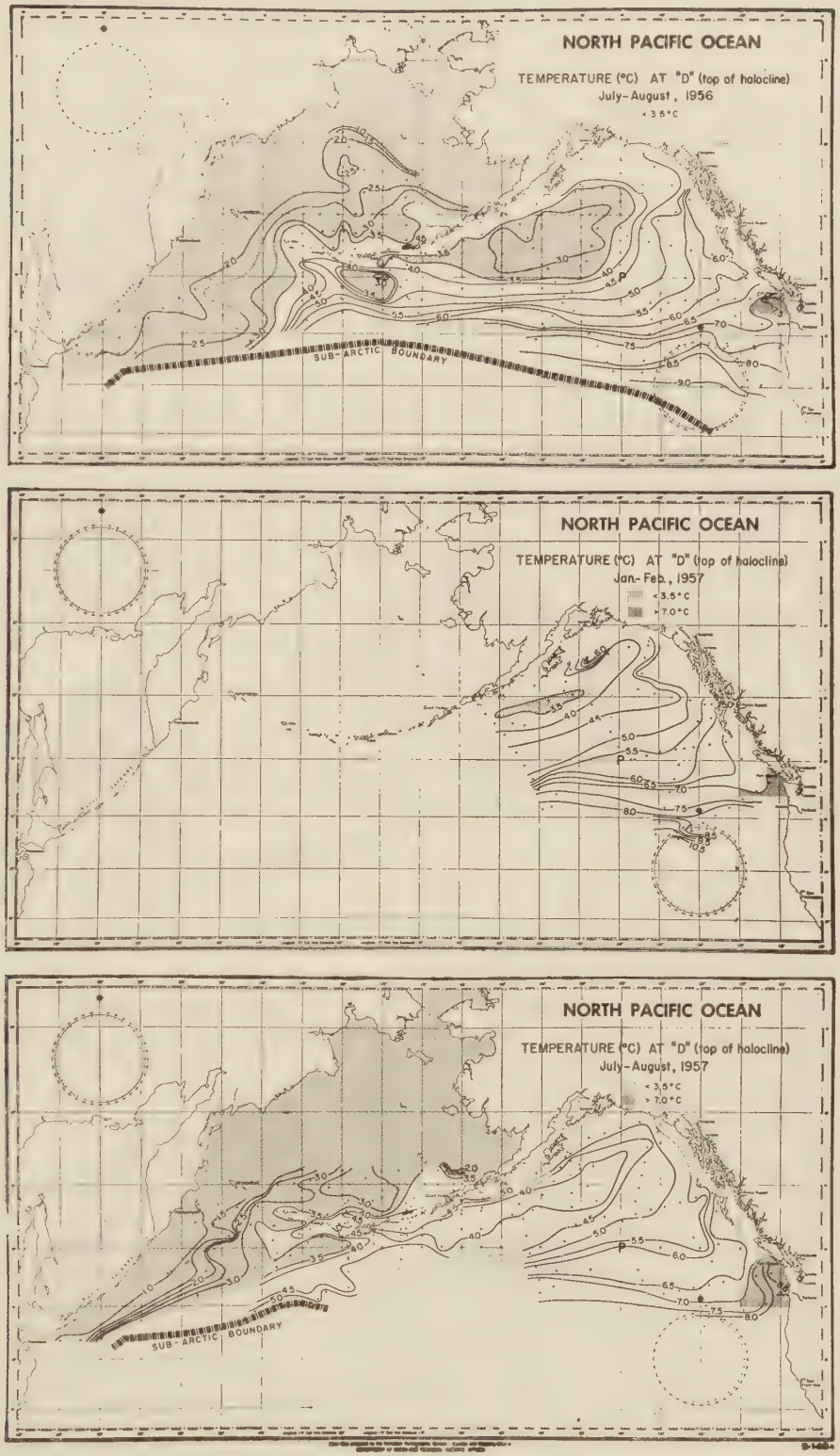

NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
July-August, 1956
< 3.5°C
SUB-ARCTIC BOUNDARY
NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
Jan-Feb., 1957
< 3.5°C
> 7.0°C
NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
July-August, 1957
< 3.5°C
> 7.0°C
SUB-ARCTIC BOUNDARY

Figure 14.

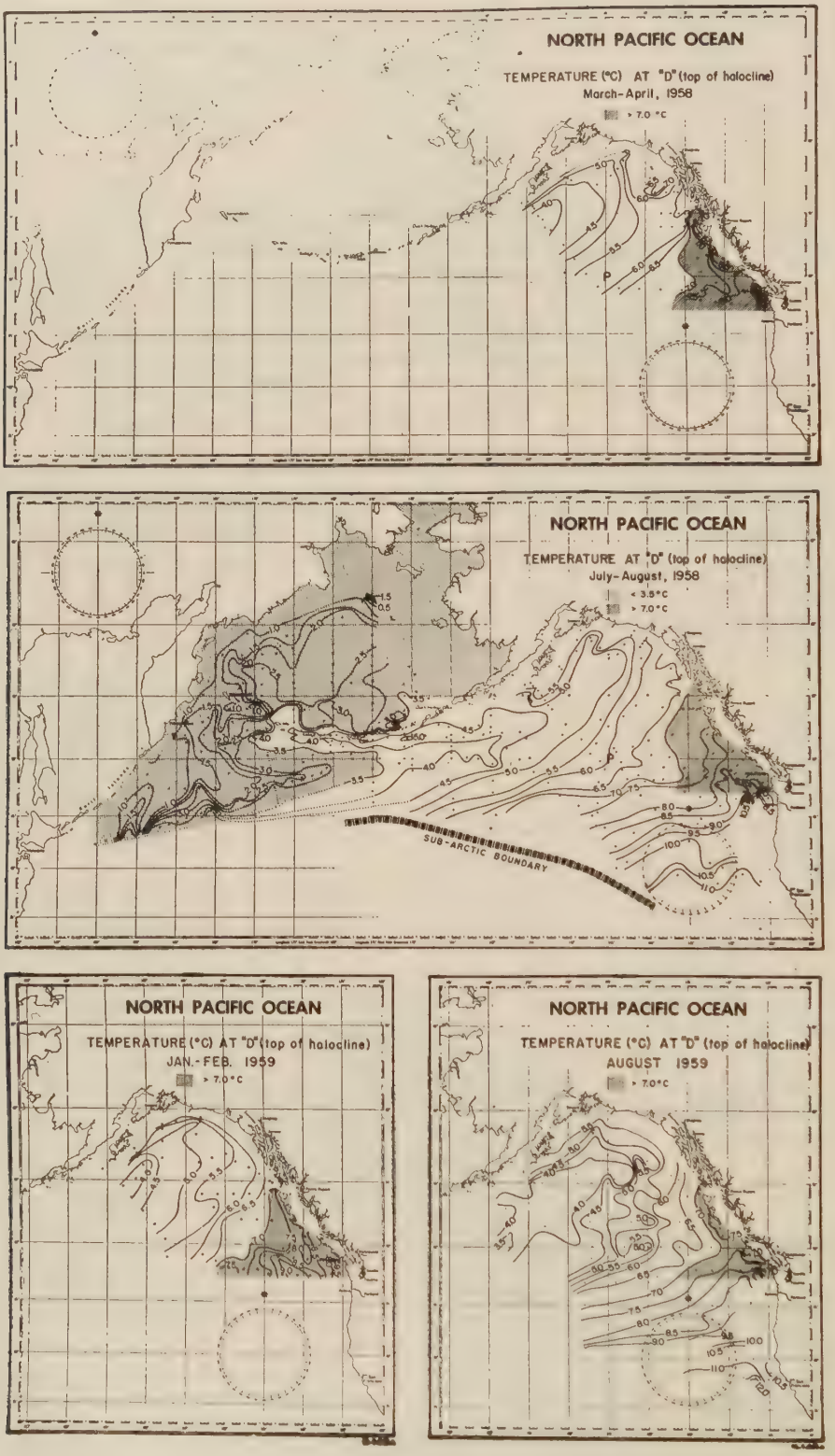

NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
March-April, 1958
> 7.0 °C
NORTH PACIFIC OCEAN
TEMPERATURE AT "D" (top of halocline)
July-August, 1958
< 3.5°C
> 7.0°C
SUB-ARCTIC BOUNDARY
NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
JAN.-FEB. 1959
> 7.0°C
NORTH PACIFIC OCEAN
TEMPERATURE (°C) AT "D" (top of halocline)
AUGUST 1959
> 7.0°C

Figure 15.

Changes that occur in the salinity structure during the period of heating can be related to the development of the marked thermocline within the upper zone and the " entrainment " processes.

There is evidence to suggest that, at least in the eastern sub-Arctic Pacific Ocean, the establishment of the isohaline and isothermal upper zone is primarily due to cooling and mixing by wind action. It is further proposed that the extremes of temperature and salinity established in the upper zone during the winter can be recognized in the summer data at depth " D ". The absolute values are altered slightly by " entrainment " (salinity 0.2‰; temperature 0.2–0.5°C).

Thus it is possible to recognize, within small limits, the winter distribution of temperature in the whole of the upper zone from the summer data at " D ". This can be seen from an examination of the winter and the following summer distributions in the eastern sub-Arctic (Fig. 14 and 15) for the years 1957 and 1958. It has been proposed that these conclusions are applicable for the whole of the sub-Arctic region for these periods.

It is noted from a casual inspection, that the summer distribution of temperature at " D " is not as representative of the actual winter distribution for 1959 as was the case for the previous periods. The apparent discrepancy between these two periods can be explained. First, there was fairly marked cooling after the completion of the winter survey (January, 1959). Thus the minimum of winter conditions was not observed. This was not the case in the other winter surveys. Secondly, it is suggested that there has been a change in the general trend of warming which has occurred from 1955 through 1958. It appears that the circulation was returning to that observed during 1956. These two factors can account for the differences observed.

These figures reflect the marked variations that have occurred during these periods. It is interesting to note that warming in the eastern sub-Arctic was accompanied by cooling in the western sub-Arctic.

B. REPORT ON THE INVESTIGATIONS BY JAPAN FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION - 1959

February, 1960

Fisheries Agency of Japan

REPORT ON RESEARCH CONDUCTED BY JAPAN IN 1959 IN REGARD TO PROBLEMS RAISED BY THE PROTOCOL

Japan continued the following research activities in connection with the problems raised by the Protocol: (1) Fishing by research vessels and investigations and sampling on motherships for the purposes of studying the offshore distribution of salmon and collecting salmon samples; (2) Scale studies and serological studies for the purpose of distinguishing stocks of sockeye, chum and pink salmon; (3) Tagging experiments on the high seas using long-line gear (partly in cooperation with United States tagging vessels); and (4) Oceanographic observations to obtain background information for studies of the offshore distribution of salmon.

1. OFFSHORE DISTRIBUTION OF SALMON

A. Collection and Analysis of Data from Commercial Catches

The work was conducted on about the same scale as in 1958. Biological measurements and scale collections were undertaken on all motherships on a daily basis.

From the data on the operations of motherships, catch statistics by species and by week (Table 1) and by species, month and area (2° latitude by 5° longitude each) with fishing effort (Table 2) were prepared.

Ages of all fish in the samples of sockeye, chum and coho salmon were determined and the results used to prepare age compositions by sex, period (ten days each) and area (2° latitude by 5° longitude each). Length frequency distribution by age and gonad weight frequency distributions were compiled in the same manner.

In Table 3, the age compositions of sockeye and chum salmon samples are shown by sex and month for each of the areas east and west of 170°E. Such data are used to study annual changes in age composition and also for comparison with the age composition of coastal catches. A remarkable feature in 1959 was that four-year-old fish were overwhelmingly dominant in the catches of chum salmon on the Asian side. The situation is very similar to that of 1955 and, accordingly, it may be expected that five-year-old Asian chum salmon will predominate in the western and central parts of the North Pacific in 1960.

In 1959, the biostatistical data on the catches of the mothership fishery, accumulated since 1956 in the abovementioned manner, were analyzed, principally for sockeye and chum salmon. The following results were obtained:

For sockeye salmon:

(1) During the last ten days of June, 1956, sockeye salmon were found in fairly high relative abundance in Bering Sea waters east of 175°E., and also during the middle and last ten days of June, 1957, extremely large quantities of sockeye salmon were found in the same waters. However, in 1958, sockeye salmon appeared only in very low relative abundance in the same waters;

(2) The relative abundance of sockeye salmon in the central Bering Sea during the three years (1956–58) have not been proportional to the corresponding coastal catches (those in Bristol Bay may be used for comparison in this case); especially in 1958, the densities in offshore waters were extremely low and not proportional to the coastal catch;

(3) When the age composition of sockeye salmon is compared between the Bering Sea waters east and west of 175°E., the fish of age 4_2 in general outnumbered those of age 5_3 in 1956 and the fish of age 5_2 in general outnumbered those of age 6_3 in 1957 in the areas east of 175°E., but the reverse tendencies were observed in the areas west of 175-E. Also, the proportions of fish that had spent three or more years in fresh water were in general higher in the western areas than in the eastern areas;

(4) When body length and gonad weight are compared between the catches from these areas for the same age group and period, the sockeye from Bering Sea waters east of 175°E. show larger values than those from waters west of 175°E.

Points (3) and (4), above, indicate that the major portions of the sockeye salmon that appeared in

the middle and last ten days of June in 1956 and 1957 in Bering Sea waters east of 175°E. were Alaskan salmon and points (1) and (2) indicate that the distribution of Alaskan sockeye salmon in this area changes greatly from year to year.

For chum salmon:

(1) During the first part of the 1956 fishing season high densities of chum salmon were observed in waters from off Kamchatka to the central North Pacific, with increasing densities towards the west in this general region. As the season progressed, the densities decreased from the eastern side and the areas of concentration shifted westward. The distribution in 1958 was not greatly different from that in 1956, but the densities of chum salmon were, in general, lower.

(2) In 1956, the proportion of five-year-old fish was high over the entire mothership fishing grounds, making a sharp contrast with the high proportion of four-year-old fish among the spawning chum salmon entering the streams of the North American continent. However, in 1957 and 1958, three and four-year-old chum salmon predominated on the Asian side.

(3) It is assumed that there are chum salmon stocks in the Olyutor-Karaginsk area that have better growth rates than the stocks in other areas of Asia.

B. Study of Offshore Distribution by Research Vessels

The following two vessels were chartered as research vessels:

Kano-maru, 152 gross tons, 330 h.p.
Wakashio-maru, 153 gross tons, 320 h.p.

The *Kano-maru*, in her first cruise, followed the course of the research vessel *Wakashio-maru* in 1958. Investigations started at 50°30′N.–180° on May 25 and ended at 56°N.–173°E. on June 22. After a return to port, the *Kano-maru* recommenced investigations at 46°30′N.–148°E. on July 9 and completed work at 53°N.–164°E. on August 22 after cruising the waters of the Okhotsk Sea and those of the Bering Sea around the Commandorski Islands with main emphasis on the study of immature salmon appearing in these waters. Fishing was conducted with gillnets of the following mesh-size composition: 4 tans of $5^1/_4''$ nets, 4 tans of $4^1/_2''$ nets, 4 tans of $3^1/_4''$ nets, 4 tans of $2^1/_2''$ nets and 50 tans of nets of commercial mesh sizes (4.0–4.1 sun

Table 1. Catch of the Japanese mothership salmon fishery in Aleutian waters by species and week, in numbers of fish and in weight, 1959.

Week	Sockeye		Chum		Pink		Coho		Chinook		Total	
	No. of fish	Weight kg.	No. of fish	Weight kg.	No. of fish	Weight kg.	No. of fish	Weight kg.	No. of fish	Weight kg.	No. of fish	Weight kg.
May 20–23	336,537	743,467	649,879	1,134,144	15,758	22,193	2	2	653	3,297	1,002,829	1,903,103
May 24–30	1,717,332	3,688,901	2,446,107	4,211,023	172,328	237,242	36	56	2,221	11,448	4,338,024	8,148,670
May 31–June 6	925,963	1,957,503	1,645,901	2,904,081	508,553	698,064	622	948	2,792	11,183	3,083,831	5,571,779
June 7–13	743,595	1,534,202	1,067,976	2,984,803	1,156,024	1,586,656	546	865	1,111	4,178	3,569,252	6,110,704
June 14–20	1,057,436	2,020,387	1,454,707	2,623,090	2,374,524	3,224,105	3,350	5,451	2,416	7,479	4,892,142	7,880,521
June 21–27	943,174	1,899,225	1,369,026	2,710,467	2,063,770	3,516,081	10,218	27,934	5,119	17,025	4,391,307	8,170,732
June 28–July 4	973,054	1,996,156	1,325,137	2,669,477	2,761,022	3,583,093	22,646	40,539	10,560	31,128	5,092,419	8,320,393
July 5–11	680,627	1,406,988	792,192	1,593,816	3,904,668	5,164,742	21,196	40,045	5,347	14,546	5,404,030	8,220,137
July 12–18	827,924	1,549,868	747,926	1,486,309	3,906,001	5,227,296	409,432	915,945	13,096	32,980	5,904,379	9,212,398
July 19–25	967,258	1,946,075	755,824	1,462,624	1,393,514	1,991,975	919,779	2,116,646	24,912	65,584	4,001,307	7,282,904
July 26–August 2[1]	12,047	20,480	3,971	7,346	111	171	29,253	66,697	176	546	45,558	95,240
Total	9,124,967	18,463,252	12,858,646	23,787,189	18,856,273	25,251,618	1,423,089	3,215,128	68,103	199,314	42,331,078	70,916,501

[1] Fishing was conducted only on July 26.

Table 2. Catch of the Japanese mothership salmon fishery in Aleutian waters by species, month and area[1], in numbers of fish, with quantities of nets used, 1959.

Month	Area	Sockeye	Chum	Pink	Coho	Chinook	Total	Quantity of nets used in tans[2]
May	A650	445,893	537,912	1,534	—	396	985,735	200,380
	B658	823,414	1,087,160	39,322	14	954	1,950,864	357,388
	B656	498,044	866,193	120,615	10	813	1,485,675	309,089
	A700	153,834	259,353	605	1	322	414,115	107,630
	B708	230,968	478,567	53,212	26	468	763,241	165,233
Sub-total		2,152,153	3,229,185	215,288	51	2,953	5,599,630	1,139,720
June	A602	55,092	26,017	46,109	20	73	127,311	23,183
	A600	94,277	95,662	181,528	189	376	372,032	67,229
	B608	290,163	959,045	1,133,423	1,151	652	2,384,434	355,417
	A652	281,365	237,873	218,618	134	721	738,711	136,491
	A650	680,317	882,350	1,049,187	1,621	2,528	2,616,003	500,755
	B658	535,343	718,650	1,091,237	17,291	4,130	2,366,651	448,624
	B656	479,531	1,048,992	1,450,236	10,750	1,828	2,991,337	592,512
	A704	44,623	48,303	184,352	22	557	277,857	35,930
	A702	248,916	460,256	539,946	96	1,127	1,250,341	216,402
	A700	314,838	837,457	644,222	1,038	1,945	1,799,500	420,395
	B708	666,061	794,434	814,304	3,272	1,417	2,279,488	477,746
	B706	33,214	27,306	35,803	229	71	96,623	30,076
	A750	271,968	336,082	502,090	83	461	1,110,684	199,175
	B758	20,947	53,888	23,006	4	96	97,941	18,736
Sub-total		4,016,655	6,526,315	7,914,061	35,900	15,982	18,508,913	3,522,671
July	A602	446,101	298,491	354,810	11,869	1,551	1,112,822	178,163
	A600	219,322	270,682	304,923	54,363	1,423	850,713	148,026
	B608	125,264	283,390	341,327	114,517	3,248	867,746	138,826
	A658	137,910	301,104	854,641	2,918	1,190	1,297,763	119,270
	A656	44,201	44,254	419,704	584	482	509,225	42,729
	A652	152,809	196,445	420,561	2,154	1,335	773,304	126,847
	A650	208,503	224,360	409,518	17,443	2,937	862,761	127,695
	B658	399,629	186,015	52,817	382,879	6,106	1,027,446	149,485
	B656	36,972	62,710	1,416	216,566	1,593	319,257	69,563
	A708	500,162	464,374	2,089,636	3,988	16,033	3,074,193	378,549
	A706	293,088	300,079	2,858,528	18,981	4,312	3,474,988	367,086
	A704	9,402	16,005	103,248	517	27	129,199	28,198
	A702	80,975	111,745	398,288	4,513	742	596,263	96,396
	A700	14,383	60,649	77,722	380	273	153,407	25,502
	B708	35,281	41,554	859	87,700	668	166,062	27,495
	B706	51,748	58,193	2,166	465,271	1,029	578,407	136,711
	C750	46,923	34,281	66,960	46	1,373	149,583	37,470
	A758	115,846	112,111	1,266,489	573	4,366	1,499,385	155,066
	A756	37,640	36,704	703,311	1,876	480	780,011	77,529
Sub-total		2,956,159	3,103,146	10,726,924	1,387,138	49,168	18,222,535	2,430,606
Grand total		9,124,967	12,858,646	18,856,273	1,423,089	68,103	42,331,078	7,092,997

[1] See figure 1.

[2] One tan measures approximately 170 feet at the float line.

Table 3a. Age composition of sockeye salmon samples from mothership catches, 1959.

Area	Month	Sex	3_1	4_1	4_2	5_2	5_3	6_2	6_3	6_4	7_3	7_4	7_5	8_4	8_5
East of 170°E	May	F	0	23	16	71	57	0	134	26	1	17	0	0	0
		M	0	12	17	32	63	0	43	17	0	12	0	0	0
	June	F	2	45	123	220	537	4	368	166	0	60	0	2	0
		M	4	26	273	83	686	0	157	164	0	31	1	0	0
	July	F	0	7	158	85	487	4	105	98	0	24	0	0	0
		M	1	6	375	74	642	1	67	141	0	19	0	0	1
West of 170°E	May	F	0	52	35	288	190	8	703	90	13	120	1	3	1
		M	0	19	44	152	272	6	318	98	4	76	0	0	0
	June	F	0	80	150	401	796	6	1,036	385	10	229	2	1	0
		M	5	42	337	167	996	1	398	366	8	111	4	2	1
	July	F	4	20	107	128	391	5	396	222	4	105	1	1	0
		M	9	10	271	118	571	4	194	256	3	47	0	1	0

Table 3b. Age composition of chum salmon samples from mothership catches, 1959.

Area	Month	Sex	3	4	5	6
East of 170°E	May	F	0	275	22	0
		M	2	206	17	0
	June	F	18	1,875	85	0
		M	51	1,269	41	0
	July	F	147	1,743	47	1
		M	244	1,090	16	0
West of 170°E	May	F	3	1,355	126	2
		M	10	990	85	0
	June	F	66	3,453	159	6
		M	179	2,326	107	1
	July	F	111	1,408	31	0
		M	184	1,014	20	0

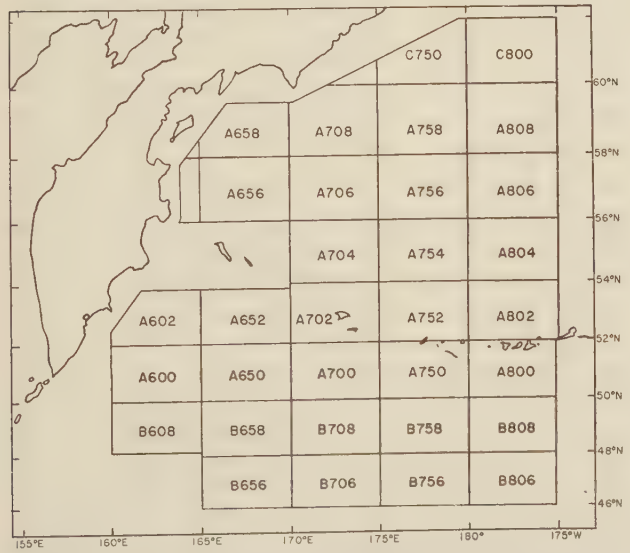


Figure 1. Chart showing fishing areas used in Table 2.

(4.75″–4.88″)), connected in this order. The salmon caught by the gillnets other than those of commercial mesh sizes were measured aboard separately for each mesh size and scales were taken. Part of the salmon taken by the gillnets of commercial mesh sizes were measured aboard and scales were taken and most of the fish in the remainders of the catches were brought home as frozen samples.

The *Wakashio-maru* occupied the southwestern part of the mothership fishing grounds and waters south of the mothership grounds with the main purpose of tagging salmon in these waters. However, she also conducted distribution studies and collected samples using 65 tans of gillnets of commercial mesh sizes.

The catch records of both vessels are shown in

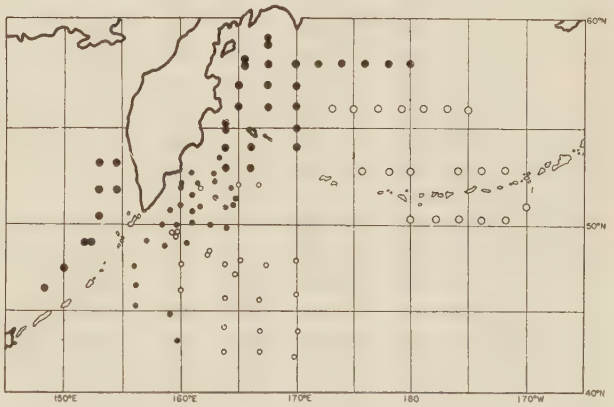


Figure 2. Stations occupied by research vessels.
Large open circles: *Kano-maru*, 1st cruise
Large closed circles: *Kano-maru*, 2nd cruise
Small open circles: *Wakashio-maru*, 1st cruise
Small closed circles: *Wakashio-maru*, 2nd cruise

Table 4a. Catch data of *Kano-maru*, 1959.

Data of set		Location		Time		Dir. of set	Surf. temp.	No. of tan	Catch (No. of fish)					
		Lat.	Long.	Set	Haul				Sockeye	Chum	Pink	Coho	Chinook	Total
May	25	50-30N	180-00	1840	0500	N	4.7°C	66	32	201	3	—	—	236
	26	50-30N	178-00W	1845	0400	NW/W	4.9	66	65	161	6	—	1	233
	27	50-30N	176-00W	1825	0430	"	5.7	66	67	88	36	—	—	191
	28	50-30N	174-00W	1820	0430	N	5.7	66	32	141	79	—	4	256
	29	50-30N	172-00W	1810	0445	NE	6.2	66	18	197	50	—	1	266
June	1	51-00N	170-00W	1910	0435	N	4.9	66	20	11	29	—	—	60
	3	53-00N	172-00W	1815	0400	SE	5.3	66	66	89	6	—	2	163
	4	53-00N	174-00W	1820	0415	WNW	5.3	66	42	11	6	—	27	86
	5	53-00N	176-00W	1825	0430	NE	4.8	66	42	49	35	—	—	126
	8	53-00N	180-00	1830	0430	ESE	4.7	66	10	39	10	—	—	59
	10	53-00N	178-00E	1850	0430	NW	5.2	66	104	37	19	—	—	160
	13	53-00N	176-00E	2150	0430	N	5.4	66	15	111	40	—	1	167
	15	56-00N	175-00W	2115	0420	NW	5.4	66	112	15	16	—	4	147
	16	56-00N	177-00W	2225		SE	5.1	66	16	28	39	—	2	85
	18	56-00N	179-00W	1840	0415	WNW	4.5	66	98	19	42	—	—	159
	19	56-00N	179-00E	2210	0440	NNW	4.2	66	85	21	24	—	—	130
	20	56-00N	177-00E	1915		NW/W	4.3	66	50	119	71	—	—	240
	21	56-00N	175-00E	1930	0440	NW/W	4.8	66	72	67	165	—	3	307
	22	56-00N	173-00E	1915		NNW	5.7	66	75	148	69	—	2	294
July	9	46-30N	148-00E	1725	0400	WSW	11.2	66	—	63	312	—	—	375
	11	47-30N	150-00E	1810	0330	NW	10.4	66	—	9	132	1	—	142
	14	49-00N	152-00E	1835	0430	NNW	8.5	*	—	7	154	2	1	164
	15	49-00N	152-00E	1840	0345	N	9.5	66	—	21	159	12	3	195
	16	50-30N	153-00E	1835	0415	NNE	8.6	66	3	41	385	18	—	447
	17	52-00N	153-00E	1840	0350	NW	8.2	66	—	56	236	13	1	306
	18	53-10N	153-00E	1840	0400	NE	8.1	66	5	395	147	3	—	550
	20	53-10N	154-30E	1910	0400	N	8.9	66	30	120	1,319	13	—	1,482
	21	52-00N	154-30E	1850	0315	N	10.1	66	19	137	458	5	—	619
	27	58-00N	180-00	2130	0545	ENE	8.0	66	36	29	20	1	1	87
	28	58-00N	178-00E	1840	0415	WNW	8.9	66	56	142	26	—	—	224
	29	58-00N	176-00E	1830	0415	W	8.6	66	27	147	45	3	1	223
	30	58-00N	174-00E	1825	0430	WNW	9.4	66	33	75	26	—	—	134
	31	58-00N	172-00E	1835	0445	WNW	9.5	66	18	292	78	—	2	390
Aug.	1	58-00N	170-00E	1830	0440	NW	10.7	66	215	137	37	2	1	392
	2	57-00N	170-00E	1840	0445	N	10.6	66	162	139	17	—	—	318
	3	56-00N	170-00E	1845	0255	NNW	11.3	66	88	40	5	5	—	138
	4	55-00N	170-00E	1850	0455	SSW	12.8	66	17	35	2	3	—	57
	5	54-00N	170-00E	1840	0450	W/N	11.7	60	51	136	2	12	—	201
	7	56-00N	167-30E	1845	0500	NW	12.9	63	46	40	3	1	—	90
	8	57-00N	167-30E	1835	0445	NW	13.6	63	31	24	4	5	3	67
	9	58-00N	167-30E	1840	0450	NW	13.2	63	123	23	1	3	—	150
	10	59-00N	167-30E	1835	0535	NW	13.2	63	37	27	11	6	—	81
	11	59-00N	167-30E	1845	0500	NW/W	13.9	63	20	31	3	10	—	64
	12	58-00N	165-30E	1845	0510	N	14.8	63	39	49	—	9	—	97
	13	58-00N	165-30E	1840	0505	SSW	—	63	38	40	3	11	—	92
	14	57-00N	165-00E	1835	0515	NNE	14.5	59	79	46	3	3	—	131
	16	56-00N	165-00E	1840	0515	W	14.3	59	34	76	—	8	—	118
	17	55-00N	164-00E	1750	0415	W	14.9	59	29	12	1	41	1	84
	18	55-00N	164-00E	1800	0415	N	—	59	52	31	2	24	1	110
	19	54-00N	164-00E	1745	0410	NNE	13.7	54	68	33	—	54	3	158
	20	54-00N	166-00E	1845	0530	N	13.1	56	182	59	4	16	4	265
	21	53-00N	166-00E	1905	0525	NE	12.9	58	171	83	—	21	8	283
	22	53-00N	164-00E	1735	0530	SSW	12.7	58	107	114	—	15	6	242
Total								3,339	2,837	4,261	4,340	320	83	11,841

Table 4b. Catch data of the *Wakashio-maru*, 1959.

Date		Location Lat.	Long.	Gear	No. of gear	Direction of set	Surf. temp.	Catch (in numbers of fish) Sockeye	Chum	Pink	Coho	Chinook	Total
					Skate								
May	23	42-07.0N	169-55.0E	Long line	50	NNW	11.7°C	0	0	1	0	0	1
	24	43-44.0N	170-0.30E	"	50	SE/E	6.0	12	110	58	0	4	184
	25	46-0.30N	169-59.0E	"	50	N	4.2	42	47	5	0	0	94
	26	48-00.0N	170-00.0E	"	50	SE/E	4.6	195	83	27	0	0	305
	27	47-57.0N	167-24.0E	"	50	SSE	5.1	18	50	3	0	0	71
	29	45-53.0N	166-49.0E	"	31	WNW	4.6	34	21	1	0	0	56
	31	43-54.0N	167-06.0E	"	50	NW/W	6.3	15	136	74	6	1	232
June	1	42-30.0N	167-00.0E	"	30	SE/E	6.8	0	90	36	5	1	132
	2	42-31.0N	163-54.0E	"	50	SE/E	6.9	0	122	222	0	3	347
	3	44-09.0N	163-54.0E	"	50	ESE	6.25	0	171	323	1	0	495
	4	46-00.0N	164-00.0E	"	30	S	5.4	3	45	21	0	0	69
	5	48-00.0N	164-00.0E	"	30	SSE	5.7	44	36	0	0	0	80
					Tan								
	6	47-32.0N	164-43.0E	Drift net	65	SE/E ¼E	4.8	26	35	4	0	0	65
	7	48-07.0N	165-11.0E	"	65	NE	5.1	37	5	9	0	0	51
	10	48-45.0N	162-37.0E	"	65	SE	5.2	19	110	57	0	0	186
	11	48-44.0N	162-31.0E	"	65	W	4.8	24	39	24	0	0	87
	13	49-47.0N	159-43.0E	"	65	W	4.9	33	51	52	0	0	136
	14	49-48.0N	159-41.0E	"	65	W½S	4.8	41	25	12	0	0	78
	16	49-31.0N	159-51.0E	"	65	NE/E	5.0	24	31	86	0	1	142
	18	52-02.0N	161-48.0E	"	65	NE/E	7.2	103	15	85	1	0	204
	20	52-00.0N	165-00.0E	"	65	SW/S	6.2	69	66	27	0	0	162
	21	52-00.0N	167-00.0E	"	65	W	6.5	57	59	63	0	1	180
					Skate								
	24	48-00.0N	160-00.0E	Long line	50	NNE	5.7	13	21	57	1	0	92
	25	46-20.0N	160-00.0E	"	50	WSW	6.1	0	80	273	3	0	356
July	16	43-06.5N	159-45.0E	"	50	ENE	13.5	0	1	0	5	0	6
	17	44-59.0N	158-52.0E	"	50	SE	11.9	0	18	31	15	0	64
	18	45-30.0N	156-08.0E	"	50	N/W	11.2	0	1	38	24	0	63
	19	46-58.0N	156-00.0E	"	50	NE/N	10.3	0	0	17	21	0	38
	20	47-58.0N	155-57.0E	"	48	NE	11.0	0	9	4	18	0	31
	21	49-15.0N	156-56.0E	"	50	NE	10.2	0	8	1	7	0	16
	22	49-00.0N	158-30.0E	"	50	NW/W	10.1	0	15	0	16	0	31
	24	49-24.0N	160-17.5E	"	50	WNW	10.4	2	21	13	57	0	93
	25	50-01.0N	158-00.0E	"	50	WNW	11.5	7	24	4	9	0	44
	26	50-03.0N	159-32.0E	"	50	W/S	11.4	6	21	1	1	1	30
	27	50-12.0N	161-00.0E	"	50	SW/W	12.6	1	22	0	39	1	63
	28	49-59.0N	162-30.0E	"	50	W/S	10.7	0	23	5	27	0	55
	30	49-50.0N	163-55.0E	"	50	W	11.6	0	89	11	47	1	148
	31	51-00.0N	163-50.0E	"	50	W/N	10.7	7	64	0	22	1	94
Aug.	1	51-00.0N	164-30.0E	"	50	W	10.1	16	106	0	24	1	147
	6	51-00.0N	162-48.0E	"	50	SSW	10.5	1	14	4	20	0	39
	7	50-49.0N	161-10.0E	"	50	E/S	11.4	1	27	3	33	1	65
					Tan								
	7	51-00.0N	160-00.0E	Drift net	65	NW	10.4	149	37	5	29	0	220
					Skate								
	9	50-50.0N	159-00.0E	Long line	50	WSW	10.7	2	14	0	33	0	49
	10	52-00.0N	160-05.0E	"	50	S	12.6	3	14	2	12	0	31
	11	52-01.0N	161-30.0E	"	50	S/E	12.2	7	15	1	28	0	51
	12	52-06.0N	163-00.0E	"	50	NNW	12.3	1	24	0	7	0	32
	13	51-44.0N	164-35.0E	"	50	NE	11.9	6	69	1	5	0	81
					Tan								
	14	51-11.0N	164-55.0E	Drift net	65	NNW	11.9	8	142	1	19	4	174
	16	51-25.0N	163-00.0E	"	65	N	11.9	11	39	2	81	5	138
	17	52-30.0N	161-00.0E	"	65	SW/W	12.2	68	74	2	93	2	239
	18	52-30.0N	161-00.0E	"	65	NE/E	12.3	71	35	3	62	11	182
	19	52-20.0N	163-06.0E	"	65	NE	12.4	92	30	4	29	1	156
	20	53-30.0N	163-30.0E	"	65	E½N	13.4	32	33	0	22	2	89
	22	52-00.0N	160-00.0E	"	65	NE½N	12.3	75	85	2	45	9	216
Total								1,375	2,522	1,675	867	51	6,490

Table 4. The stations occupied are indicated in Figure 2.

Analysis of the data obtained by the research vessels is now in progress. One of the features revealed so far is that sockeye salmon that have spent one winter in the ocean appeared in large numbers. Thus, the 30 sockeye salmon caught by four tans of $2^1/_2$″ nets at 53°N.–180° on June 4 were almost all one-ocean-winter fish; and many fish of this age category were caught by $3^1/_4$″ nets in an area bounded by 56°–58°N. and 165°–170°E. during the first and second ten days of August.

In all waters occupied by research vessels four-year-old fish predominated in chum salmon catches as they did in the mothership catches. For the first time, fishing with gillnets of small mesh sizes, $2^1/_2$″ and $3^1/_4$″, was conducted in the Sea of Okhotsk. It is noteworthy that on some occasions over ten two-year-old chum salmon per tan were caught by these nets.

The mothership fishery took large quantities of pink salmon in the western Bering Sea, indicating very high relative abundance of pink salmon in this region. However, the catches by research vessels did not indicate such extremely high relative abundance. The reason for such discrepancies is not known at present.

2. STUDIES FOR DISTINGUISHING STOCKS

A. Studies by Scales

Sockeye Salmon: Among the major age categories of sockeye salmon, the 5_3 group was studied. The characters used are the distance between the nucleus and the second annulus (abbreviated RF)

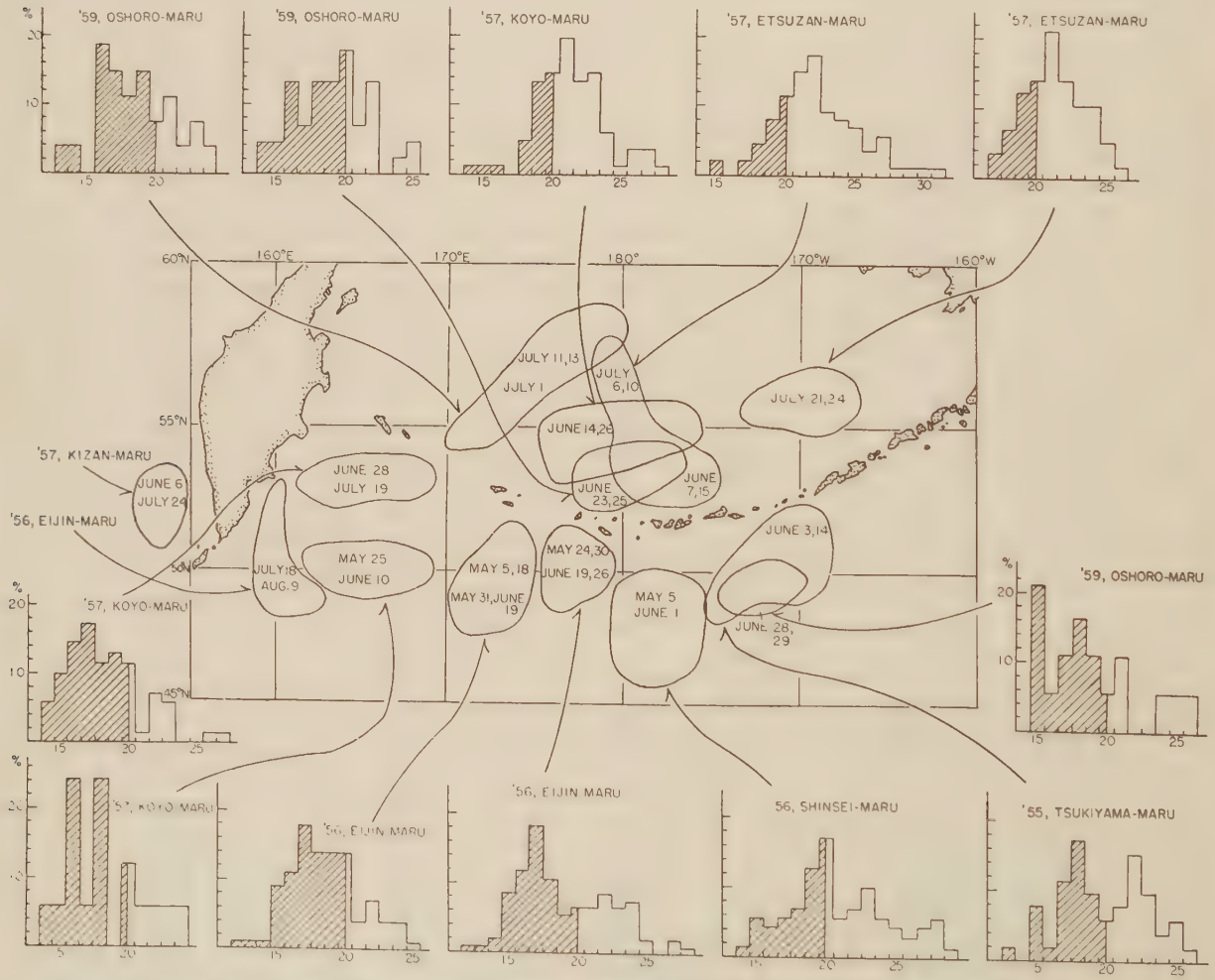


Figure 3. Frequency distribution of RF/RS_2 for 5_3 age group in samples from high seas. (Shaded areas indicate Asian type fish)

Table 5. Frequency Distribution (%) of numbers of scale circuli in the first two years of life from chum salmon collected from coastal areas and offshore waters.

Area	42 or less	43-49	50 or more
Yukon River	20.6	76.3	3.1
Kuskokwim River	4.1	79.6	16.3
Cook Inlet	10.9	73.2	15.9
King Cove	31.1	63.5	5.4
Kodiak Island	24.5	67.3	8.2
Skeena River	0	19.6	80.4
Karaginski	77.8	22.2	0
Okhotsk Sea	72.8	27.2	0
Hokkaido	29.3	66.7	4.0
135°W-55°N	0	54.3	45.7
170°-165°W—54°-57°N	27.4	66.3	6.3
170°-160°W—50°-52°N	58.8	33.8	7.4
180°-175°W—53°-59°N	84.3	15.3	0.4
180°-175°W—49°-50°N	86.7	13.3	0
160°-165° E—50°-53°N	64.5	33.9	1.6

and the distance between the nucleus and the fourth annulus (abbreviated RS_2). The material used consisted of scales collected from the catches of research vessels, motherships and coastal fisheries during 1955 through 1957.

The value of RF itself shows differences between Asian sockeye and Alaskan sockeye, being smaller in the former. However, for various reasons, the value of RF/RS_2 was used in the present analysis. First, variations caused by the location on the body from which the scale is taken, sex, year-class, and age at maturity (between fish maturing at 5_3 and those maturing at 6_3 and higher) were examined for their significance. The results indicated that the differences from these sources of variations were not large and that the value of RF/RS_2 was useful for distinguishing the sockeye stocks of the two continents.

Taking the samples from off southeast Kamchatka and the Okhotsk Sea as the standard for Asian fish and those from Bristol Bay as the standard for American fish, the proportions of Asian and American sockeye in the catches from offshore waters were estimated for the age group 5_3, using the frequency distribution of RF/RS_2. The result indicates, as shown in Figure 3, that Asian sockeye salmon are found in considerable numbers as far east as about 180° in the Bering Sea and as far east as about 170°W. in the North Pacific waters south of the Aleutians. However, their proportions are not as high as in 6_3 and 5_2 age groups.

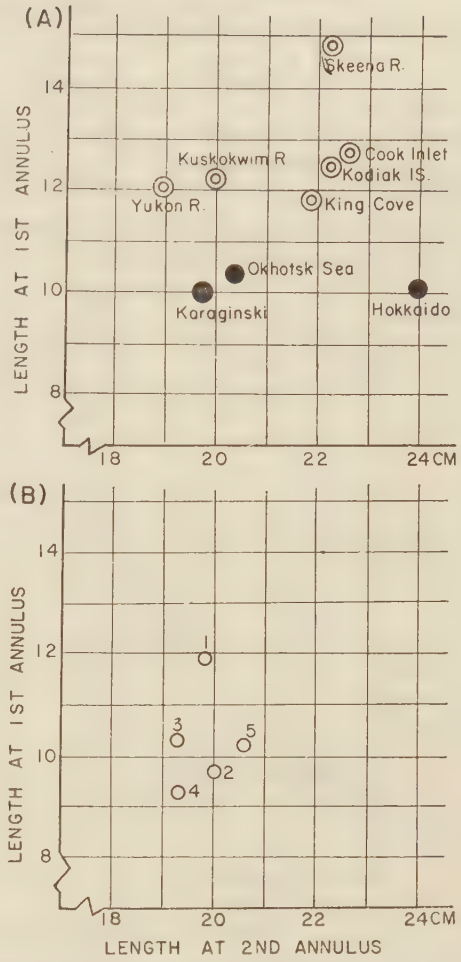


Figure 4. Relationships between the average calculated lengths (body proper) corresponding to the first and second annuli of 4-year old chum salmon collected in 1957.

A—Coastal samples
B—Offshore samples
1—170°-165°W., 54°-57°N.
2—170°-165°W., 50°-52°N.
3—180°-175°W., 53°-59°N.
4—180°-175°W., 49°-51°N.
5—160°-165° E., 50°-53°N.

Chum Salmon: Four-year-old fish sampled in 1957 were studied. First, the numbers of circuli in the first year band and those in the second year band were counted and compared among the samples from various coastal areas and offhore waters. The average number of circuli in the first year band was on the American side, 31.58 for Skeena River chum salmon, 28.37 for Cook Inlet, 27.96 for Kodiak Island, 26.55 for King Cove, 27.13 for the Kuskokwim River and 25.09 for the Yukon River. For the chum salmon from the Asian side, the average

Table 6. Research cruises of *Tenyo-maru* and *Wakashio-maru*.

	Left Hakodate	Began tagging	Entered Adak*	Entered Kushiro	Entered Adak*	Completed tagging	Entered Hakodate
Tenyo-maru	may 29	June 8	June 8 June 11	—	July 25 July 26	August 22	August 29
Wakashio-maru	may 12	May 23	—	June 28 July 6		August 13	August 28

* For making arrangements for Japan–U.S. joint investigations.

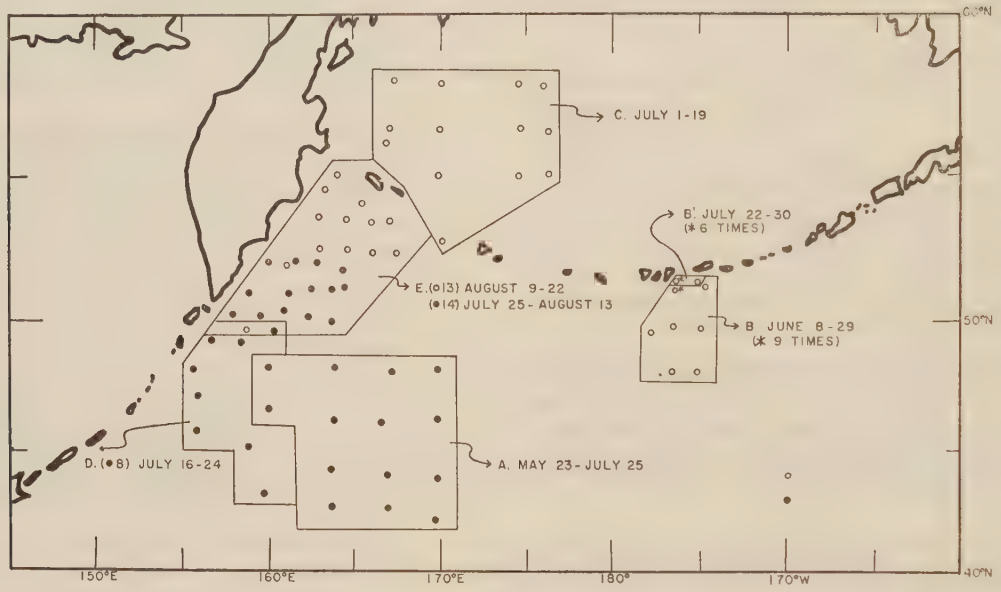


Figure 5. Tagging locations in 1959. *Tenyo-maru* and *Wakashio-maru*)

was 29.67 for Hokkaido, 24.83 for the Okhotsk Sea and 24.40 for the Karaginsk area. In general, the average number of circuli in the first year band increases toward the south on both continents. The average number of circuli in the second year band varies between 17.77 and 21.15 on the American side and between 14.41 and 16.42 on the Asian side, thus showing large differences between the continents.

Furthermore, in the total number of circuli in the first and second year bands, there is no overlapping in the frequency distribution between Kamchatka chum salmon and chum salmon from the Skeena River of British Columbia. The chum salmon from Hokkaido, Northwestern Alaska and Central Alaska come in between these two extremes. Based on the above findings, the proportions of fish with total numbers of circuli in the first and second year bands of 42 or less, 43–49 and 50 or more, respectively, were determined for coastal samples from both continents. The proportions of fish belonging to the same categories were determined for offshore samples and compared with those for coastal samples. The result of this analysis is shown in Table 5. It is indicated that the chum salmon found in the central parts of the North Pacific are mostly Asian fish and that chum salmon from the Skeena River of British Columbia are found in very small numbers or are almost absent in these waters.

Secondly, from body length and scale measurement data, the calculated lengths of the body proper at the formations of the first and second annuli were determined, respectively. The results are shown in Figure 4. The increment of body length proper in the first year is the largest for Hokkaido chum salmon and in general larger in southern areas than in northern areas on both the Asian and American continents. The increment in the second year is especially large for Skeena River chum salmon, however, other stocks of North America show more-or-less similar increments. The Asian chum stocks are similar to each other with respect to the increment

Table 7. Catch and release by tagging vessels, 1959. (*Tenyo-maru* and *Wakashio-maru*)

Area*	Period	No. of tagging operations	Cumulative quantity of gear used in skates	Sockeye[1)]	Chum[1)]	Pink[1)]	Coho[1)]	Chinook[1)]	Total[1)]	Remarks
A	May 23–June 25	14	621	266 376	769 1,011	596 1,101	10 17	2 9	1,643 2,514	Wakashio-Maru
B	June 8–June 29	15	615	512 649	627 845	576 940	2 3	31 36	1,748 2,473	Tenyo-maru
B[1]	July 22–July 30	7	350	307 446	284 409	40 45	225 280	29 37	885 1,217	Tenyo-maru
C	July 1–July 19	13	533	120 149	542 744	684 957	2 6	81 102	1,429 1,958	Tenyo-maru
D	July 16–July 24	8	398	2 2	58 73	71 104	106 163		237 342	Wakashio-maru
E	Aug. 9–Aug. 22	13	560	469 732	456 942	11 17	215 363	32 43	1,183 2,097	Tenyo-maru
	July 25–Aug. 13	14	700	47 58	375 528	22 32	184 305	6 6	634 929	Wakashio-maru
Sub-total (E)		27	1,260	516 790	831 1,470	33 49	399 668	38 49	1,817 3,026	
Total by vessel		48	2,058	1,408 1,976	1,909 2,940	1,311 1,959	444 652	173 218	5,245 7,745	Tenyo-maru
		36	1,719	315 436	1,202 1,612	689 1,237	300 485	8 15	2,514 3,785	Wakashio-maru
Grand total		84	3,777	1,723 2,412	3,111 4,552	2,000 3,196	744 1,137	181 233	7,759 11,530	

* See figure 5.

[1)] Upper: Number of fish released.
Lower: Number of fish caught.

Table 8. Results of fishing by long-line using sand lance and anchovy as bait

Date	No. of skates			Number of fish caught											
				Sockeye		Chum		Pink		Coho		Chinook		Total	
	Sand lance	Anchovy	Total	Sand lance	Anchovy	Sand lance	Anchovy	Sand lance	Anchovy	Sand lance	Anchovy	Sand lance	Anchovy	Sand lance	Anchovy
July 24	20	30	50	—	2	7	14	1	12	16	41	—	—	24	69
25	30	20	50	6	1	14	10	1	3	5	4	—	—	26	18
26	30	20	50	—	6	9	12	—	1	1	—	—	1	10	20

in the second year, but they show smaller increments than the North American stocks.

As shown in the figure, among five groups of samples of unknown origin taken from offshore waters, four groups, the exception being a group of samples taken from 165°–170°W. and 54°–57°N., have increments in the second year similar to those for Asian coastal samples.

Pink Salmon: Since 1958 was a year of poor production for Asian pink salmon, only a few samples were obtained from the central parts of the North Pacific and accordingly, analysis was limited to the fish from limited areas. Based on analysis of the samples obtained from the catches of the Hokkaido land-based drift net fishery in the waters from off Hokkaido to the southwestern part of the mothership fishing grounds, it was revealed that the pink salmon from various areas of Asia did not show large differences in either the number of circuli in the first year band or in the spacing of circuli in the second year band.

Table 9. Catch and Release by tagging vessel *Tenyo-maru*, 1958.
(Revised December 1959)

Area	Period	No. of tagging operations	Cumul. quantity of gear used in skates	No. of fish caught and No. of fish released[1]					
				Sockeye	Chum	Pink	Coho	Chinook	Total
A 49–52°N 175W–176°E	June 5– June 19	15	557	72	365	59	1	4	501
				81	486	104	1	8	680
B 48–53°N 157–172°E	June 25– July 24	21	930	335	571	184	25	6	1,121
				415	871	273	40	8	1,607
C 51–56°N 160–166°E	July 29– Aug. 18	18	865	727	777		124	1	1,629
				899	1,172	3	173	2	2,249
Total	June 5– Aug. 18	54	2,352	1,134	1,713	243	150	11	3,251
				1,395	2,529	380	214	18	4,536

[1] Upper: Number of fish released.
Lower: Number of fish caught.

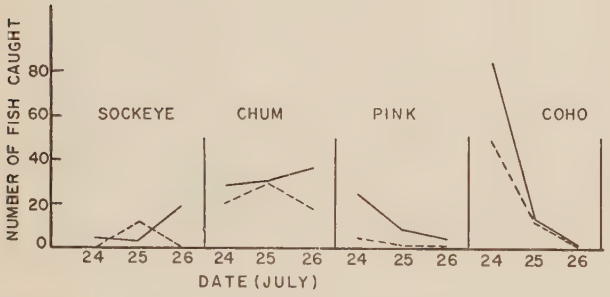


Figure 6. Catches by long-line using sand lance and anchovy as bait. Converted to numbers of fish per 60 skates.
Broken line: Catch by sand lance
Solid line: Catch by anchovy

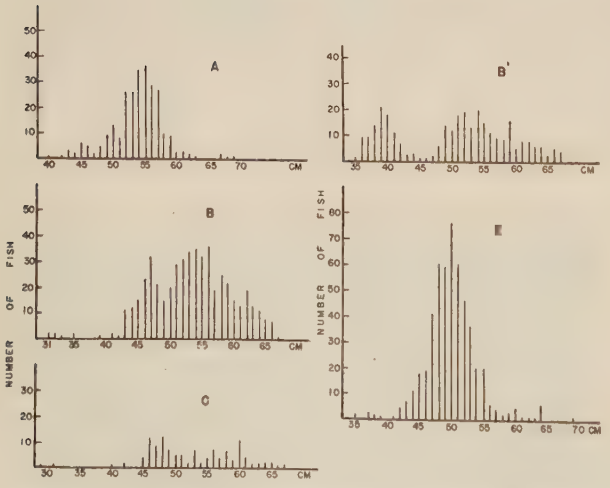


Figure 7–1. Length composition of sockeye salmon tagged, 1959. (Fork length; both sexes combined; A–E indicate areas of tagging)

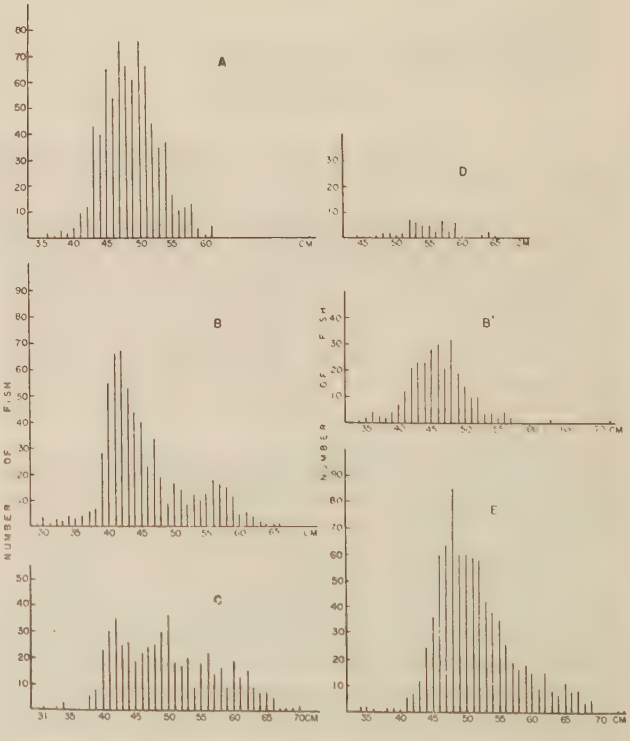


Figure 7 2. Length composition of chum salmon tagged, 1959. (Fork length; both sexes combined; A–E indicate areas of tagging)

Table 10. Recaptures from 1958 tagging by area of release[1)2)]
(As of January 20, 1960)

Area of release	Species	Mothership fishery		High seas	Alaska	Hokkaido	East Kam. coast	West Kam. coast	Okhotsk coast	Sakhalin (incl. Etorofu Island)	Total
		Off East Kamchaka	Off West Kamchaka	South of 48°N							
A	Sockeye	2			4						6
	Chum	7			1		2	2			12
	Pink				1						1
	Total	9			6		2	2			19
B	Sockeye	90 (2)	2				3	3			98 (2)
	Chum	35 (1)		2 (2)		1	1			3	42 (3)
	Pink	32	10	2							44
	Coho	6						1	1		8
	Chinook			1							1
	Total	163 (3)	12	5 (2)		1	4	4	1	3	193 (5)
C	Sockeye	(30)					1				1 (30)
	Chum	(6)		(1)		11	1		1	1	14 (7)
	Coho						10				10
	Total	(36)		(1)		11	12		1	1	25 (37)
Total	Sockeye	92 (32)	2		4		4	3			105 (32)
	Chum	42 (7)		2 (3)	1	12	4	2	1	4	68 (10)
	Pink	32	10	2	1						45
	Coho	6					10	1	1		18
	Chinook			1							1
	Total	172 (39)	12	5 (3)	6	12	18	6	2	4	237 (42)

[1)] Figures in parentheses show recaptures in 1959.

[2)] As a result of re-examination, changes in species identification have been made in this table which correct information given in the corresponding table (10) of the INPFC Annual Report for 1958.

B. Serological Studies

The results of analysis of 1959 samples from the high seas are now being compiled. It is planned to compare these results with the results of analysis of the samples which were collected from the American coast in 1959 and are to be made available for Japan this year (1960).

3. STUDY OF MOVEMENTS BY TAGGING

Tagging was conducted by the *Tenyo-maru* (221.16 g.t., 430 h.p.) and the *Wakashio-maru* (153 g.t., 320 h.p.) during 1959. The itineraries and tagging locations of these two vessels are shown in Table 6 and Figure 5, respectively.

The long-line gear used was about the same as in 1958, except that slightly heavier main lines and larger hooks were used in 1959. Salted anchovy (*Engraulis japonicus* (Schlegel)) was used as bait as in 1958, but the *Wakashio-maru* experimentally used sand lance (*Ammodytes tobianus personatus* (Girard)) in July and later. Tags were made of white vinyl tubes made in the United States.[1)]

The waters covered by the tagging vessels in 1959 were divided into six areas as shown in Figure 5 and the numbers of fish caught and the numbers of fish tagged are shown in Table 7 for each of these areas. The *Tenyo-maru* tagged 5,245 fish (in 48 operations) during the whole period and the *Wakashio-maru* tagged 2,514 fish (in 36 operations).

On three occasions, anchovy and sand lance were used alternately for each ten skates of the standard 50 skate set, and the fishing efficiency of these two kinds of bait was compared (Table 8). In Figure 6 the catches by these two kinds of bait were compared in terms of catch per 60 skates. As is obvious from this figure, as far as the result of the present series of experiments shows, fishing is more efficient with anchovy than with sand lance. However, the experiments are insufficient to allow generalizing of the conclusions.

The length composition (fork length) of tagged

1) Annual Report, 1957 (INPFC), p.74.

Table 11. Recaptures from 1959 tagging by area of release.
(As of January 20, 1960)

Area of release*	Species	Area of recapture: Mothership fishery: Off East Kamchatka	Mothership fishery: In the Bering Sea	Aleutian area	High seas South of 48°N	Hokkaido (incl. Honshu)	Alaska (incl. Kodiak)	B.C.	Unknown	Total
A	Sockeye	40	1							41
	Chum	22			2	1			1	26
	Pink	6	1		6				1	14
	Coho				1					1
	Total	68	2		9	1			2	82
B	Sockeye		1				11	1		13
	Chum	4		3						7
	Pink		6							6
	Total	4	7	3			11	1		26
B[1]	Sockeye			1			1			2
	Chum					2				2
	Coho						8			8
	Total			1		2	9			12
C	Sockeye		4				1			5
	Chum		9			6				15
	Pink		18							18
	Total		31			6	1			38
D	Pink				2					2
	Coho				2				1	3
	Total				4				1	5
E	Chum					16				16
	Total					16				16
Total	Sockeye	40	6	1			13	1		61
	Chum	26	9	3	2	25			1	66
	Pink	6	25		8				1	40
	Coho				3		8		1	12
	Total	72	40	4	13	25	21	1	3	179

* See figure 5.

fish is shown in Figures 7–1 and 7–2 for sockeye and chum salmon, respectively, by area of release. It is difficult to distinguish mature from immature salmon from these length compositions. However, it is hoped that the length composition of tagged fish will be useful for distinguishing mature from immature salmon when sufficient data of recaptures after one or two years of tagging have become available.

The numbers of salmon caught and the numbers of salmon tagged during 1958 are shown in Table 9 by area of tagging and the recaptures from tagging in 1958 and 1959 are shown in Tables 10 and 11 and Figures 8 (1 & 2) and 9 (1 to 4). The recaptures during 1958 from tagging in 1958 are not shown in the figures. The recapture data are as of January 20, 1960. However, since we have not yet received recapture reports from the U.S.S.R. there will be some additions in the future. Among these recaptured fish, the following examples are especially significant for understanding of the distribution and migration of salmon:

The sockeye salmon (32 fish) and chum salmon (10 fish) tagged in waters off East Kamchatka in 1958 and recaptured during the early part of the 1959 fishing season in southern waters of the high seas give important clues to knowledge of the feeding grounds and wintering grounds of these populations.

One sockeye salmon tagged in an area south of and some distance from Adak Island (Area B) in 1959 and recaptured at Somerville Island on the British Columbia coast in the same year and eight coho salmon tagged in an area immediately south of Adak Island (Area B′) and recaptured in Alaska

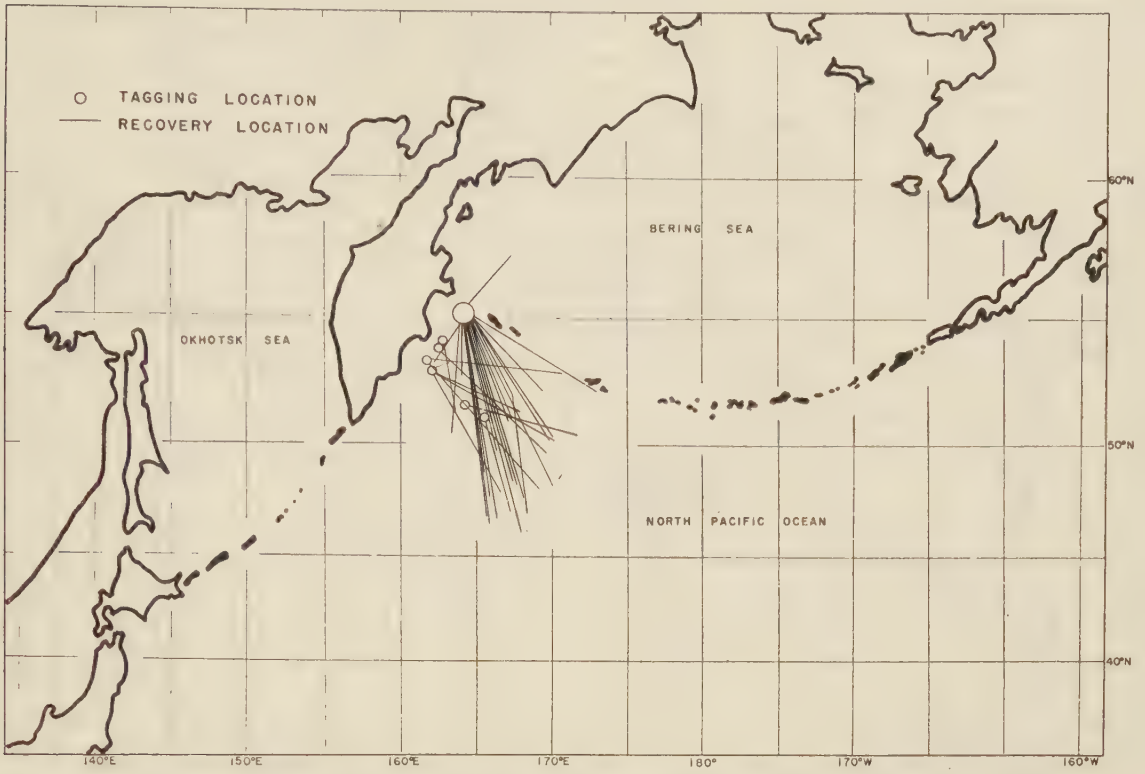


Figure 8–1. Sockeye salmon tagged in 1958 and recaptured in 1959.
Number of fish released: 1,134
Number of fish recaptured: 32

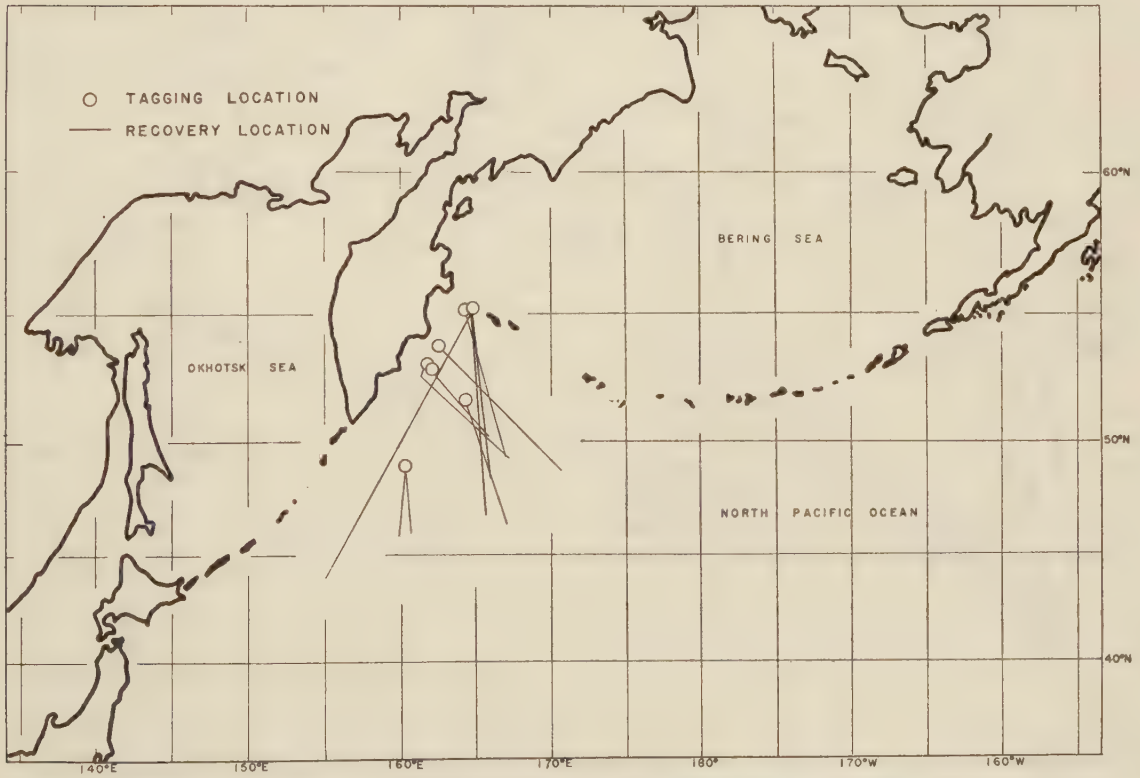


Figure 8–2. Chum salmon tagged in 1958 and recaptured in 1959.
Number of fish released: 1,713
Number of fish recaptured: 10

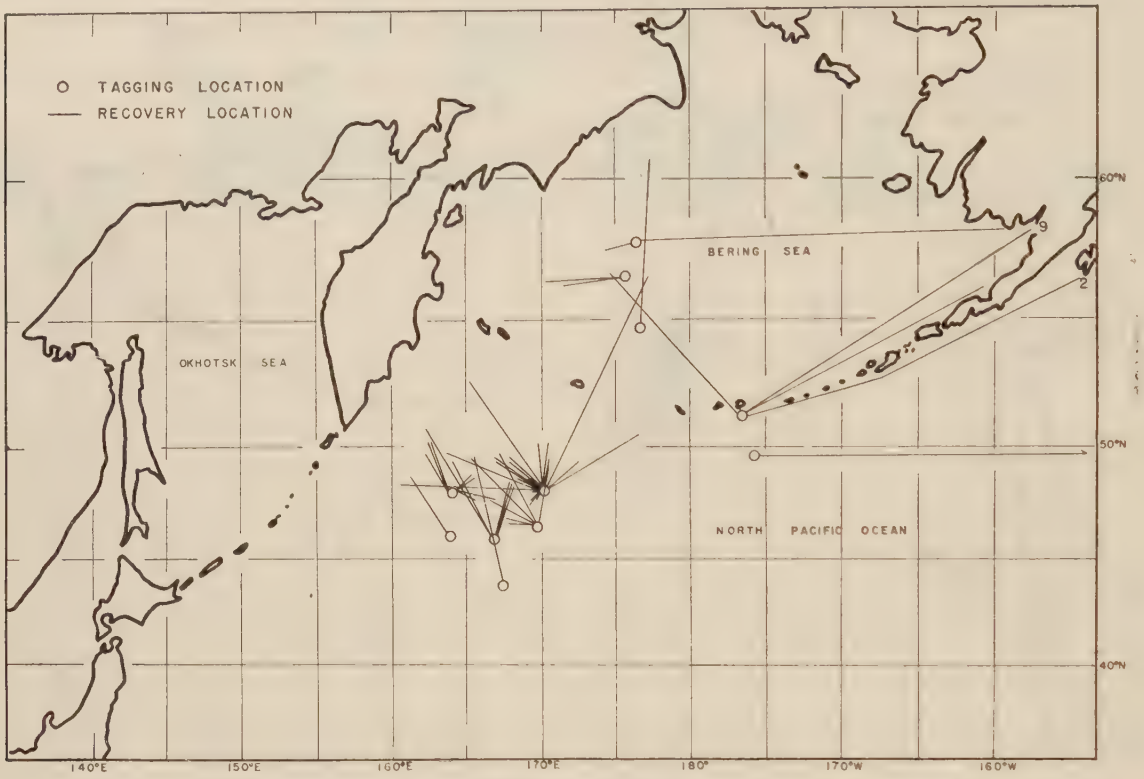


Figure 9–1. Sockeye salmon tagged in 1959 and recaptured in 1959. (Figures at ends of lines indicate numbers of fish recaptured in the same areas)
Number of fish released: 1,723 Number of fish recaptured: 61

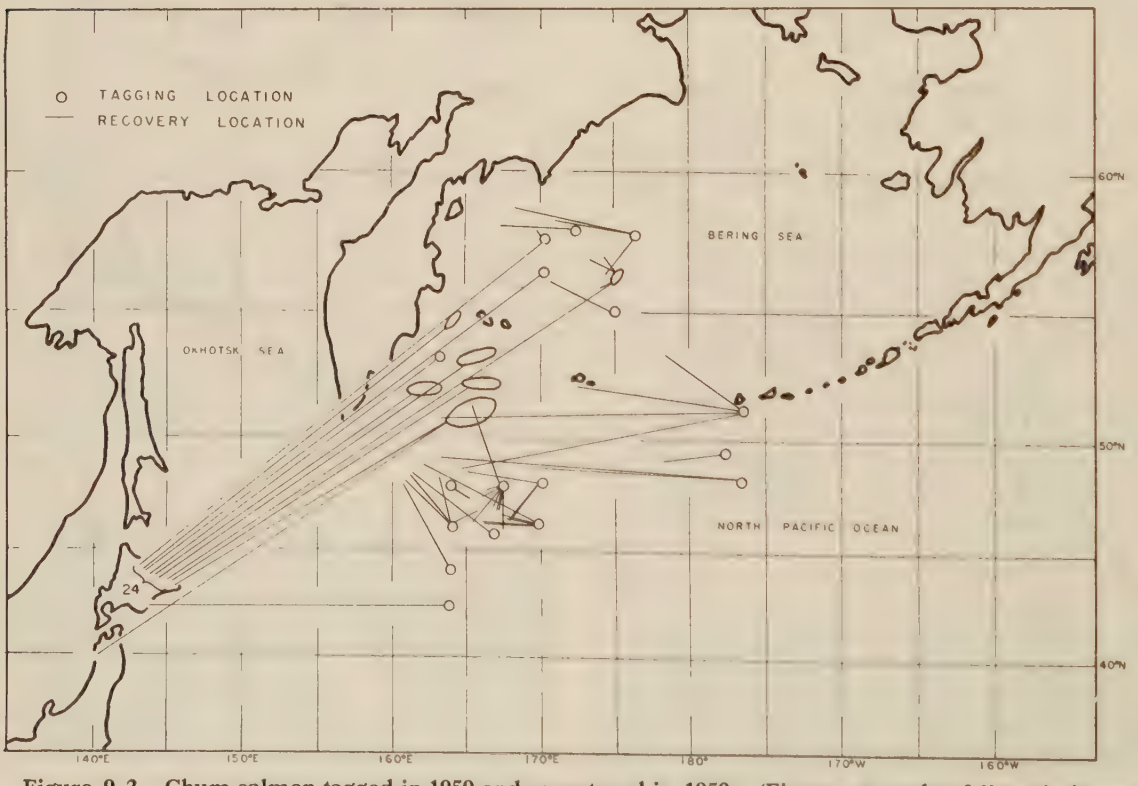


Figure 9–2. Chum salmon tagged in 1959 and recaptured in 1959. (Figures at ends of lines indicate numbers of fish recaptured in the same areas)
Number of fish released: 3,111
Number of fish recaptured— (including one from unknown location): 66

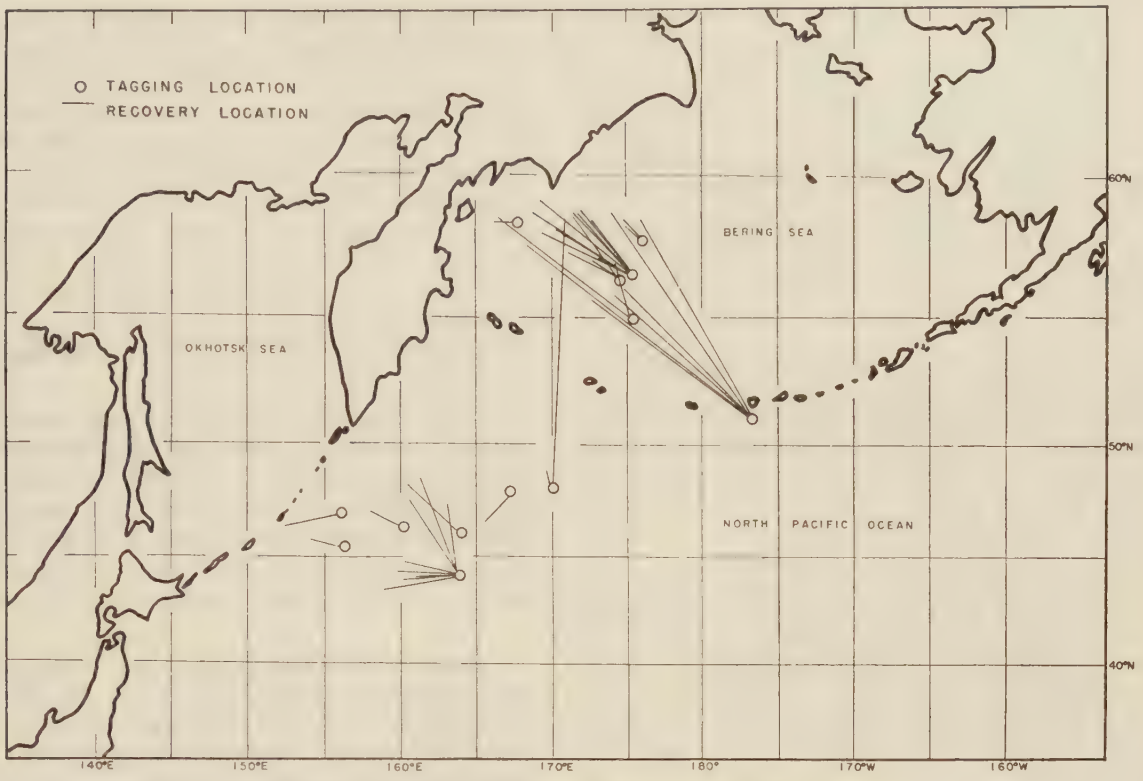


Figure 9–3. Pink salmon tagged in 1959 and recaptured in 1959.
Number of fish released: 2,000
Number of fish recaptured— (including one from unknown location): 40

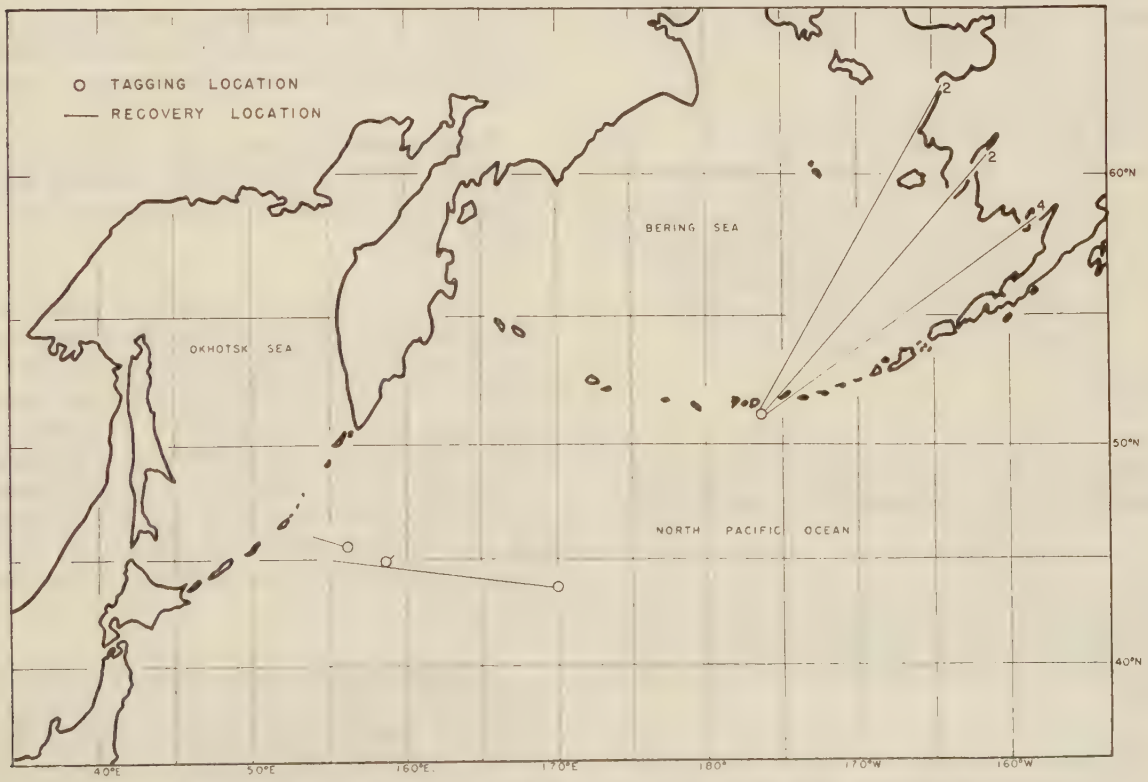


Figure 9–4. Coho salmon tagged in 1959 and recaptured in 1959. (Figures at ends of lines indicate numbers of fish recaptured in the same areas)
Number of fish released: 181
Number of fish recaptured— (including one from unknown location): 12

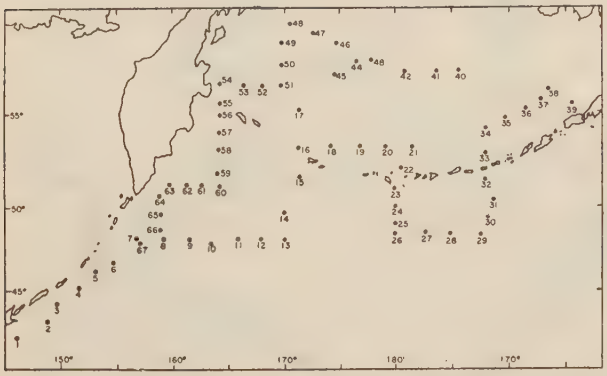


Figure 10. Stations occupied by *Oshoro-maru* during June–July, 1959.

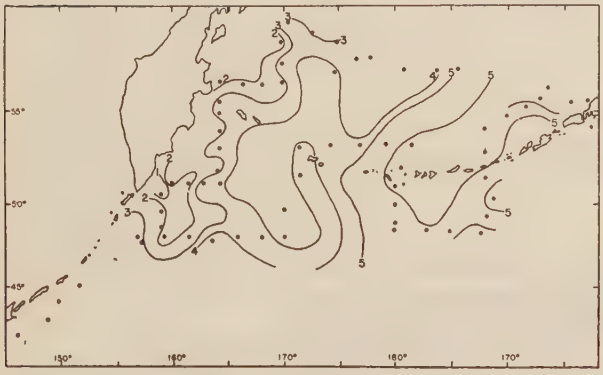


Figure 11. Horizontal distribution of temperature at 50 m. level (°C.).

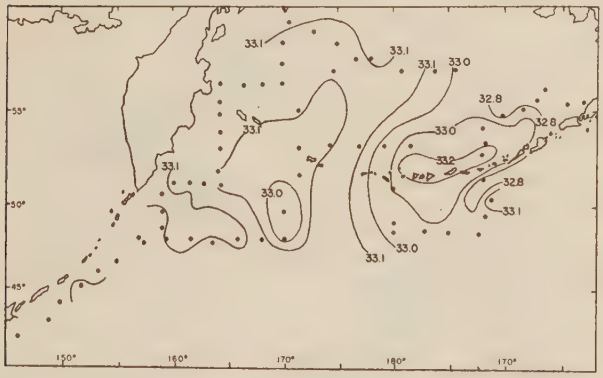


Figure 12. Horizontal distribution of salinity at 50 m. level (‰).

(Bristol Bay, the Kuskokwim River and the Yukon River) are noteworthy, because they indicate movements that have not been shown by previous examples.

Tagging in the area of 42°–48°N, and 160°–170°E. (Area A) was first conducted in 1959 and therefore the results are valuable. Particularly, one sockeye salmon and one pink salmon which were recaptured after moving from this area into the Bering Sea indicate the existence of a migration route that has not been indicated by the results of previous tagging experiments. We look forward with interest to receipt of the coastal recaptures from these tagging lots in the tag recovery reports from the U.S.S.R., which are expected in the future.

4. OCEANOGRAPHIC INVESTIGATIONS IN 1959

As in previous years, the *Oshoro-maru* (617.-72 g.t.), a training vessel of the Department of Fisheries of Hokkaido University, investigated the waters of the Bering Sea, Aleutian Islands and the northwest Pacific during June and July, that is, during the salmon fishing season, and occupied 67 stations. The stations are shown in Figure 10.

Temperature measurement and water sampling were conducted at depths of 0, 10, 20, 30, 50, 75, 100, 150, 200, 300, 400, 500, 600, 800, 1,000, 1,200, and 1,500 meters. Salinity determinations, chemical analyses of phosphate and silicate and measurements of turbidity were made from the water samples.

These data are now being compiled, but a brief summary of the temperature and salinity conditions during June and July of 1959 is given below.

Temperature (Figure 11). Temperature was generally 1°–2°C. higher than during the same period of 1958, particularly in the eastern and western Bering Sea.

A band of water of about 5°C. extended along the southern side of the Aleutian Islands and into the Bering Sea through the vicinity of Kiska Island between 175°E. and 180° and extended toward the northeast in the Bering Sea. Temperature was lower than 4°C. in the waters west of this band and lower than 2°C. in the waters of the shelf areas along Kamchatka, being as low as below 1°C. in an area off the southern tip of the Kamchatka Peninsula. Oceanic fronts were observed between these temperature regions.

Salinity (Figure 12). Salinity was about 0.1–0.2‰ lower than in 1958 in the waters west of 180°. A band of low salinity water, lower than 33.0‰, reached the vicinity of 180° along the southern side of the Aleutian Islands, extended

northward into the Bering Sea and further extended northeastward. There was an isolated area of low salinity around Stations 13 and 14. In 1958, salinity was about 33.2‰ in this vicinity and was the highest for this depth level. A band of water with a salinity of 33.1‰ extended approximately due east from the southern tip of the Kamchatka Peninsula.

Since the oceanographic data are now being processed, it is not possible to make a current chart based on geopotential topography and therefore we can only make rough conjectures on the prevailing currents from the distribution of temperature and salinity. The band of water along the southern side of the Aleutian Islands characterized by higher temperature, about 5°C., and lower salinity, lower than 33.0‰, was that of the return flow and the flow entered the Bering Sea at around 180° and then ran northeastwards. The low salinity water at around Stations 13 and 14 characterized by temperature around 4°C. and salinity below 33.0‰ seemed to be the tip of the return flow that had been cut off by the northern edge of the Subarctic Current which ran northward at around 175°E. It also appears that this northern edge of the Subarctic Current entering the Bering Sea expanded over the western Bering Sea along a counter-clockwise gyral formed in the waters west of approximately 180°.

It is assumed that the above mechanism brought about such oceanographic characteristics in 1959 as higher temperatures and lower salinities than in 1958.

REPORT OF RESEARCH ON KING CRAB IN THE EASTERN BERING SEA

Fisheries Agency of Japan

King crab studies in the eastern Bering Sea in 1959 were conducted by a research worker who was aboard the crab mothership. The type of work conducted on the crab fishing grounds was the same as in previous years.

Fishing Operations in 1959

During the spring of 1959, the Japanese crab fishing fleet encountered the most extensive ice field observed in the Bering Sea since 1953. Fishing operations were disturbed by this ice field for about two weeks. Nevertheless, the fishing results were extremely good and the catch per tan of tangle nets was as high as 16.5 crabs (Figure 1). The catch by month, canned crab production and composition of scouting net catches are shown in Tables 1, 2 and 3, respectively. The tangle net fishing grounds are shown in Figure 2. The bottom temperature of the fishing grounds was much lower than usual and below 1°C. during the greater part of the fishing season (Table 4).

Figure 1. Catch per tan of tangle net (in number of crabs).

Analysis of Records of Commercial Catches

By comparing the records of commercial catches for the years 1953 through 1959, it is found that the tangle net fishing grounds have been approximately the same every year (Figure 3), but the fishing periods for different grounds and the catch per tan

Table 1. Catch by month, 1959.

Period	No. of tans hauled**	Average No. of days net soaked	No. of crabs caught	Catch per tan	No. of cases packed
April 23*–30	9,808	3.6	90,497	9.2	4,752
May 1–31	33,292	16.3	552,710	16.6	30,253
June 1–30	33,390	26.0	621,126	18.6	33,033
July 1–2	1,874	27.5	27,285	14.6	1,962
Total	78,364	19.1	1,291,618	16.5	70,000

* Date of beginning of hauling.

** "Tan" is a unit of tangle-nets, one tan measuring approximately 130 feet at the lead line.

Table 2. Canned crab production, 1959.

No. of days operated*	No. of mother-ships	No. of inde-pendent boats**	No. of deck-loade boats***	No. of tans hauled	No. of crabs caught	Catch per tan	No. of cases packed****	No. of crabs per case
73	1 (5,385 g.t.)	2	8	78,364	1,291,618	16.5	70,000	18.5

* April 21 to July 2. The mothership arrived at the grounds on April 14, but tangle-net fishing started on April 21.

** Engaged in setting tangle nets and scouting nets and hauling scouting nets.

*** Engaged in hauling tangle nets.

**** In terms of cases of 48 half-pound cans each. This year 30,000 cases of 24 one-pound cans each, 35,000 cases of 48 half-pound cans each and 5,000 cases of 96 quarter-pound cans each were packed. Also, 910 cases of tanner crabs of 48 half-pound cans each were packed.

Table 3. Composition of catch by scouting nets, 1959.

Month	No. of operations	No. of tans hauled	No. of crabs caught	Catch composition %				
				Males	New-shelled males	Undersized males	Females	Tanner crabs
April*	135	680	8,512	39.0	2.5	0.6	9.7	48.1
May	157	780	16,385	64.7	0.8	1.0	14.5	19.0
June**	46	230	5,040	71.3	1.9	2.9	15.5	8.5
Total	338	1,690	29,937	58.5	1.5	1.2	13.3	25.5

* April 18–30.
** June 1–7.

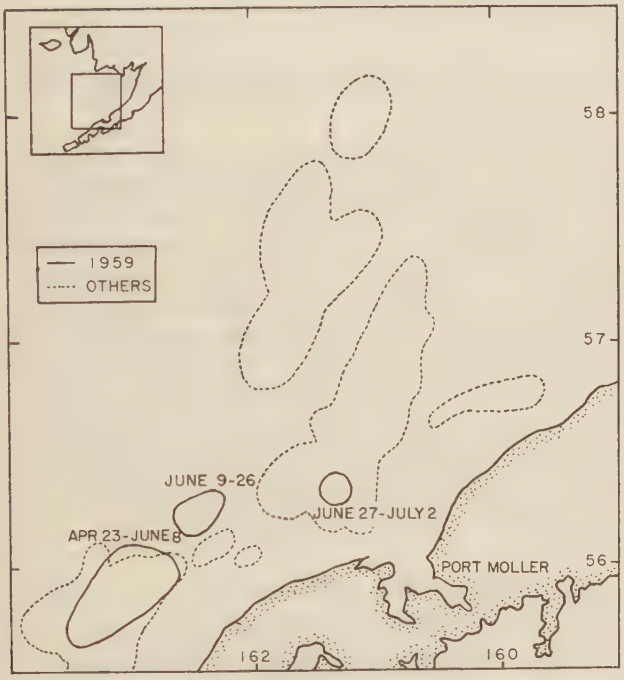


Figure 2. Tangle net fishing grounds, 1959.

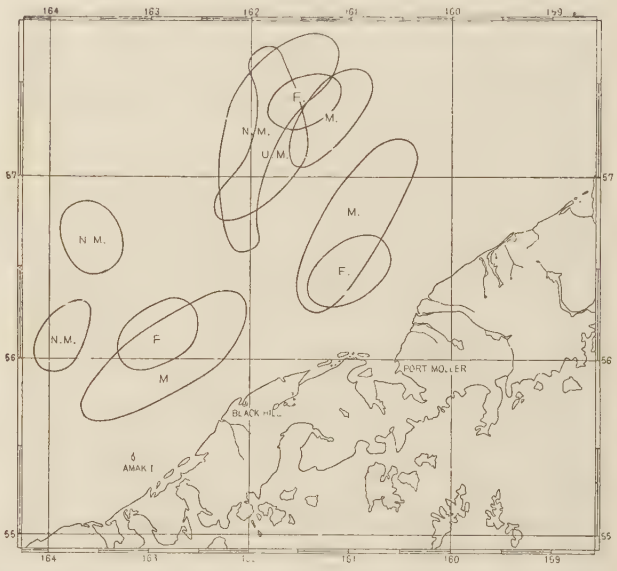


Figure 3. Major areas of concentration of king crabs —April–July.
M.—Male crabs of commercial size
N.M.—Male crabs of commercial size with new shells
U.M.—Undersized males
F.—Female crabs

Table 4. Bottom temperature and depth of fishing grounds.

Period	Area*	Bottom temp. (°C.)	Depth (m.)	Number of observations
April 14–30	Off Amak Island	0.98	92.2	16
May 1–31	Off Amak Island	0.7	87.5	30
June 1–8	Off Amak Island	0.80	82.8	8
June 9–26	Off Black Hill	0.66	79.6	18
June 27–July 2	Off Port Moller	2.14	67.5	5

* See figure 2.

of tangle nets vary considerably between years.

a. Male Crabs of Commercial Size (130 mm. or larger in maximum carapace width)

Every year they are found in April in an area off Amak Island. Heavier concentrations were observed in this area in 1957, 1958 and 1959. The catch per tan of tangle nets was over 10 crabs in these years and 4–5 crabs in the other years.

In May, crabs appear in the waters off Amak Island and Port Moller. During the years 1953 through 1955 the fishing grounds were mostly off Black Hill and Port Moller but during 1956 and later the fishing grounds were located in the waters from off Amak Island to off Black Hill. Heavier concentrations were present from late May on in the former years and through the month of May in the latter years, except in 1956.

In June, the fishing grounds were mostly in the waters off Port Moller in all years, except that in 1956 they were closer to the shore than in the other years. Heavy crab concentrations were observed each year in this area except in 1956. The density was especially high in 1957. However, in 1959, fishing was conducted almost entirely in an area off Black Hill during June and a record catch per tan of tangle nets of over 20 crabs was obtained in the middle of the month. During June, 1956, and late June, 1958, the catch per tan was less than 10 crabs, being much lower than in the other years.

In July, the fishing grounds are still in the waters off Port Moller, but they tend to be farther away from the shore than in June. This tendency was especially noticeable in 1956. The density of crabs is usually somewhat lower than in June and it was especially low in 1956.

From 1957 on, crab schools of seemingly high concentrations have appeared from the beginning of the fishing season (early April) in the waters from off Amak Island to off Black Hill. This has resulted in good catches. Especially in 1959, 66 out of 73 actual fishing days were spent in this area with extremely good results.

Analysis of the catch records of scouting nets (tangle nets) which are set in wider areas than ordinary tangle nets show approximately the same results as mentioned above. In 1956 crabs did not form heavy concentrations in any particular areas, but they appeared to spread over a wider area of waters than in the other years. On the other hand, schools of heavy concentrations appeared to be present in limited waters in 1957, 1958 and 1959. In 1959, especially heavy concentrations were observed (8—9 crabs per tan of scouting nets) in part of the waters off Black Hill.

The catch records of scouting net fishing include catches of such other categories of crabs as " males of commercial size with new shells ", " undersized males " and " females ". As a result of analysis of these records, which are complete for the years from 1955 on, some preliminary information has been obtained regarding the areas where crabs of the above categories appear and the periods when they are found.

b. Male Crabs of Commercial Size with New Shells

The crabs of this category are much fewer than those of other categories in tangle-net catches. It appears that they are distributed in more offshore waters than males of commercial size with old shells (Figure 3). In 1955 and 1956 they were scattered in the waters off Port Moller, mostly during July. The catch per tan of scouting nets was about one crab in this area in these years. On the other hand, in May, 1957, and April, 1958 and 1959, more concentrations of newshelled crabs were found in the waters off Amak Island and even heavier concentrations of these crabs appeared to be present in the waters further offshore during May, 1957.

c. Undersized Male Crabs

These crabs seem to be under-represented in the catches of tangle nets because of net selectivity. It appears, however, that relatively high concentrations of these crabs are found in the waters off Port Moller, mostly from late June through July (Figure 3). Catch data are scanty for these crabs for the years 1957 and later, because scouting net fishing was completed in late June in these years.

d. Female Crabs

Female crabs appear in larger quantities in about the same areas as male crabs of commercial size. However, somewhat larger quantities of female crabs are found in the waters off Port Moller during May and June than in the waters off Amak Island during April. It is difficult to learn the distribution of female crabs during the moulting season from the catch records of scouting nets (tangle nets), which are very selective.

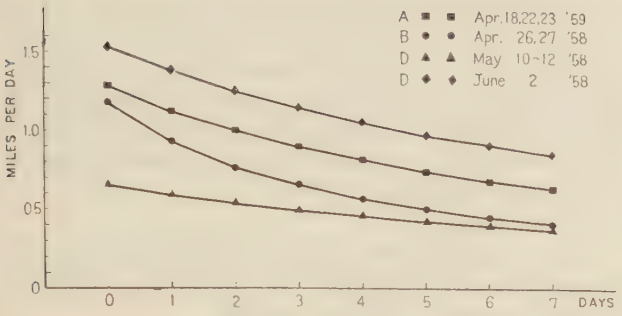


Figure 4. Estimated average distance of movement per day. (See text).

Figure 5–A. Direction of movement of tagged crabs.
A—April 18, 22 and 23, 1959
B—April 26 and 27, 1958
C—May 8, 1958
D—May 10–12, 1958

The abovementioned results of analysis of catch records are preliminary and, for various reasons, they do not give a summarized picture of the distribution of king crabs in the eastern Bering Sea during April through July. Tangle nets are selective, as mentioned above; the fishing grounds do not sufficiently cover the area of distribution of king crabs; and the fishing period is different between different waters. Nevertheless, it is hoped that the collection and analysis of these data will be of some help to the study of the distribution of king crabs in this region.

Study of Movements by Tagging

Tagging in 1959 was conducted by the same

Figure 5–B. Direction of movement for crabs covering distances over two miles.

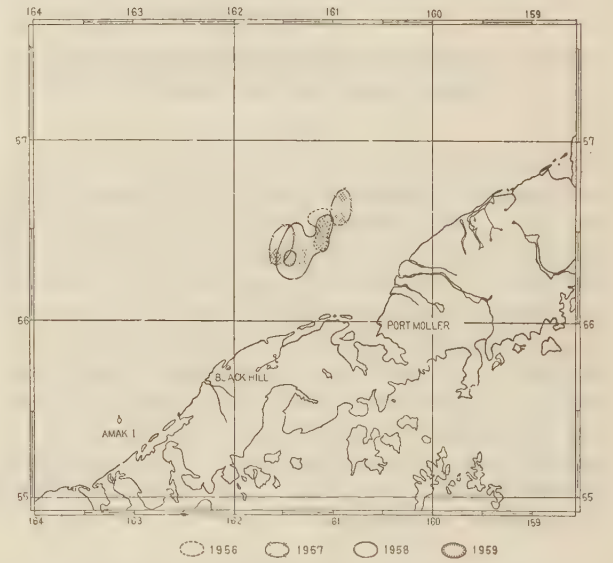


Figure 6. Areas from which juvenile crabs were collected. (Shaded areas indicate those of high concentrations)

method as in 1958. 616 male crabs of commercial size were tagged in an area off Amak Island on April 18, 22 and 23, 1959. According to the recapture data for crabs tagged in 1958 and 1959, the largest distance covered by a crab during the fishing season was 43.4 nautical miles. The average distance per day seems to differ between different areas and periods. If we assume that the recaptured crabs were caught by the particular tangle nets on the day

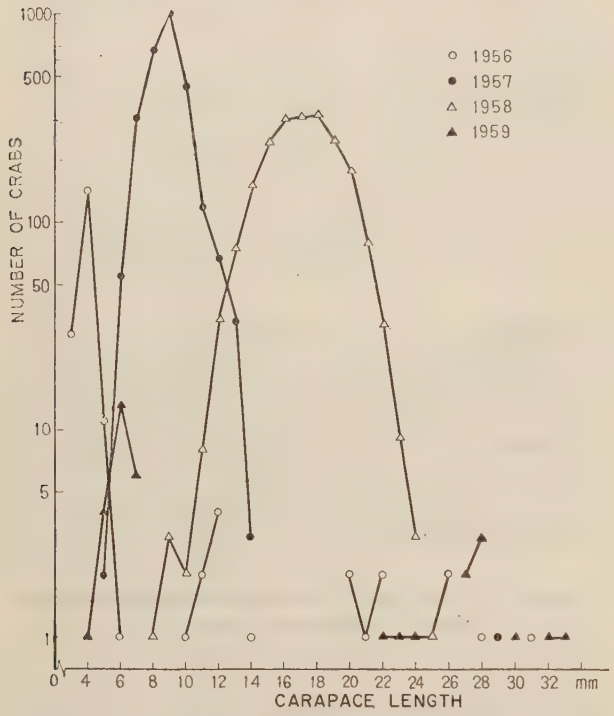


Figure 7. Logarithmic frequency distribution of carapace lengths of juvenile crabs, 1956–1959.

of casting these nets, the average speed of migration is estimated at approximately 0.6—1.5 nautical miles per day. Since experiments conducted in 1958 indicated that tangle nets became ineffective after five days of setting in the sea, the lower limits of the estimated speeds of migration may be calculated on the assumption that the recaptured crabs were caught by the particular tangle nets a week after setting of these nets. The average speed of migration calculated this way is approximately 0.4—0.8 nautical miles per day (Figure 4). The crabs tagged off Port Moller during June, 1958, showed the highest speed of migration.

It is difficult to find any definite tendencies regarding the directions of movements. Figure 5–A shows the directions of movements for the crabs tagged at the stations surrounded by commercial fishing grounds so that there were equal chances of recovery for all directions. (The thickness of each arrow indicates the percentage of crabs having moved along this particular direction in the total number of crabs recaptured.) When the recoveries within relatively short distances (less than two miles) are omitted in order to eliminate any bias caused by the locations of tangle nets close to the tagging positions, the result as shown in Figure 5–B is obtained. According to this figure, more crabs moved toward the northeast in the Amak area in 1959. In 1958, crabs moving northeastward were still most numerous, but considerable numbers of crabs moved northwestward. In the grounds off Port Moller, more crabs seem to have moved northward than in any other direction in 1958.

There were no movements from the areas off Amak Island and Black Hill to the area off Port Moller during the fishing season.

Juvenile Crabs

Juvenile crabs were first collected in 1956 from the organisms fouling tangle nets, seemingly marine Hydrozoa. The numbers of juvenile crabs collected in the same manner since then are shown in the following table by year:

Year	Main period of collection	Number of crabs collected
1956	6/13–6/20	203
1957	5/29–6/15	3,084
1958	5/29–6/18	2,172
1959	6/27–7/1	36
Total		5,495

The major areas of collection are in the waters off Port Moller as shown in Figure 6 and are approximately the same every year. The carapace length frequency distribution of these crabs is shown in Figure 7. It is not known whether the progression of the mode of distribution during 1957–58 reflects the annual growth (about 9 mm.) of juvenile crabs, or if it was caused by the selective method of collection or by a difference in crab growth between these years.

8.8% of the juvenile crabs collected in 1958 had soft-shells, indicating that they were caught immediately after moulting. The carapace length frequency distribution of these crabs does not seem to be greatly different from that of hard-shelled juvenile crabs shown in the above figure.

Meat Content

Canning experts aboard the crab mothership *Tokei-maru* have studied the meat content of crabs since 1953 for the purpose of determining how the meat content varies not only by size but also by the condition of shell or the period of fishing.

Table 5. Summary of meat condition study.

Year	Condition of carapace	Period	Days of investigation	No. of crabs sampled	Carapace length, mm.			Total weight, gr.			Meat weight, gr.			Merum meat weight, gr.			Meat weight-Total weight ratio %	Merum meat weight-Total weight ratio %
					Largest	Smallest	Average	Largest	Smallest	Average	Largest	Smallest	Average	Largest	Smallest	Average		
1953	Old shell	4/30–7/29	11	38			169.6			3,592.4			878.3				24.4	
	Very old shell	4/29–7/29	10	25			174.6			3,712.1			809.0				21.8	
	New shell	5/9 –8/6	8	43			153.9			2,618.6			488.0				18.6	
1954	Old shell	4/25–6/16	8	23			164.0			3,809.3			953.2				25.0	
	Very old shell	4/27–6/16	7	16			170.4			4,048.4			925.6				22.9	
	New shell	5/29–7/3	4	20			137.4			1,805.7			382.9				21.2	
1955	Old shell	4/19–7/14	12	33			186.5*			3,059.3			784.5				25.6	
	Very old shell	4/19–6/19	11	23			207.2*			3,902.8			884.8				22.7	
	New shell	5/21–7/25	4	21			193.9*			3,151.5			662.8				21.0	
1956	Old shell	5/2 –8/3	19	210	195	137	168.0	5,625	1,988	3,598.3			869.2			390.0	24.2	10.8
	Very old shell	5/2 –5/11	2	10	189	160	174.8	4,875	2,813	4,027.7			919.7			405.9	22.8	10.1
1957	Old shell	5/1 –6/26	9	70	181	139	160.7	4,500	1,875	3,015.2	1,184	463	758.4	543	207	334.2	25.2	11.1
	Very old shell	5/16–6/26	4	18	191	160	173.2	5,250	2,888	3,727.2	1,264	659	919.4	557	284	382.4	24.7	10.3
1958	Old shell	4/19–6/19	8	72	188	125	158.9	4,450	1,350	3,003.1	1,035	276	754.7	478	142	325.9	25.1	10.9
	Very old shell	6/15–6/19	2	4	166	155	161.5	3,400	2,750	3,112.5	795	636	710.8	335	260	297.5	22.8	9.6
	New shell	4/30–6/15	2	2	147	142	144.5	2,100	1,800	1,950.0	377	362	369.5	172	150	161.0	18.9	8.2
1959	Old shell	4/18–6/27	8	80	195	132	162.7	4,400	1,800	3,030.0	1,348	479	854.7	560	186	339.1	28.2	11.5

* Carapace width.

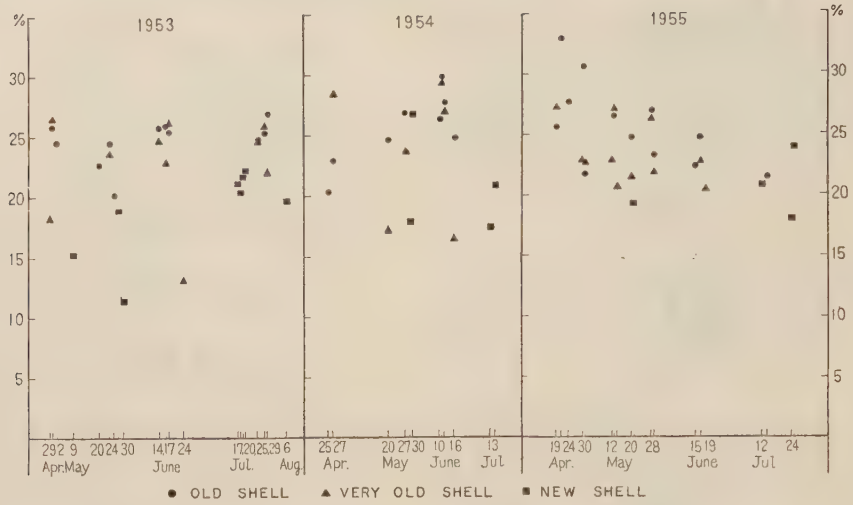
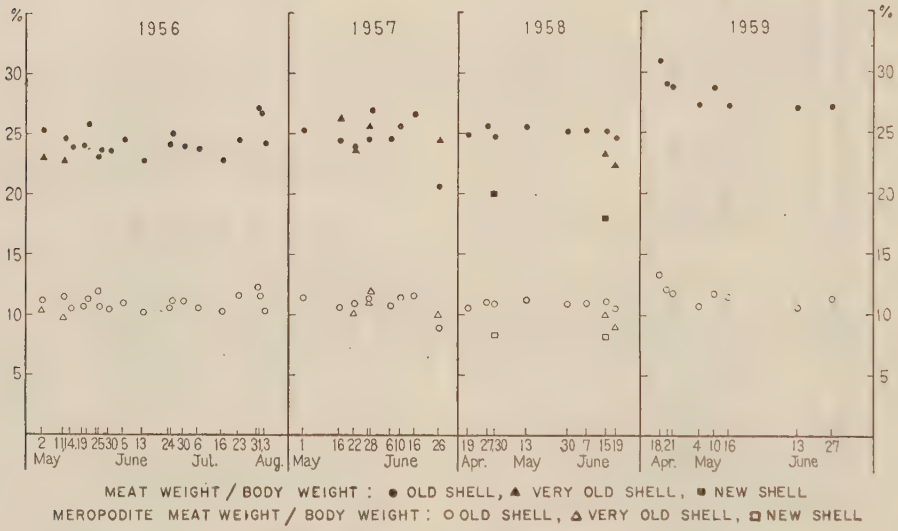


Figure 8–A. Meat weight-total weight ratio, in %, by time of catch, 1953–1955.


%
1956
1957
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2 11 14 19 25 30 5 13 24 30 6 16 23 31 3
May June Jul. Aug.
1 16 22 28 6 10 16 26
May June
19 27 30 13 30 7 15 19
Apr. May June
18 21 4 10 16 13 27
Apr. May June
MEAT WEIGHT / BODY WEIGHT : ● OLD SHELL, ▲ VERY OLD SHELL, ■ NEW SHELL
MEROPODITE MEAT WEIGHT / BODY WEIGHT : ○ OLD SHELL, △ VERY OLD SHELL, □ NEW SHELL

Figure 8–B. Meat weight-total weight ratio and merus meat weight-total weight ratio, in %, 1956–1959.

The samples used were crabs killed on fishing vessels and brought to the mothership; and also different types of scales were used for measuring total body weight and for measuring meat weight. This introduces certain inaccuracies in the results. Nevertheless, it is possible to roughly determine the differences in meat content by shell condition or fishing period (Figure 5).

Most of the crabs used for canning are those belonging to the category of "old-shell". These old-shell crabs do not show much difference in meat content by fishing period except in 1955.

Crabs with "very old shells" were much scarcer in samples than crabs with "old shells", but they seem to have smaller meat content than the latter, on the average. Also, sometimes there are large differences between the crabs with "very old shells" caught at about the same time. Crabs with "new shells" are even scarcer in samples, but it is indicated that their meat content is the lowest (Figure 8).

C. REPORT ON THE INVESTIGATIONS BY THE UNITED STATES FOR THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION - 1959

The following summaries of the investigations are intended to provide a brief review of the work done during 1959 and our present status with regard to this work. Several portions of the studies have progressed to the point that comprehensive reports of the research are being prepared.

The chum salmon parasite studies have been discontinued because of the difficulties mentioned in the 1958 Annual Report of the Commission. It became evident that infestation by *Anisakis* sp. increased rapidly during the latter years in the ocean when a fish might well be far from its native stream. Further, several North American areas were found to have infection rates similar to those in Asia.

Other than this, it is anticipated that the investigations will proceed at about the same level and along the same lines as in 1959.

The work reported herein was done by the following men with the assistance of their staffs and with the kind cooperation of scientists from Canada and Japan. Distribution and Racial Sampling of Salmon on the High Seas—Mitchell Hanavan; Oceanography—Felix Favorite; Salmon Racial Sampling and Morphological Studies—Francis Fukuhara; Study of Scales—Kenneth Mosher; Serology—George Ridgway; Tagging—Allan Hartt; King Crab—Takashi Miyahara.

DISTRIBUTION AND RACIAL SAMPLING OF SALMON ON THE HIGH SEAS

Vessel Operations

Two vessels were under charter during the 1959 season to collect samples of salmon for racial identification, to measure the abundance and distribution of salmon, and to collect data relating the ocean environment to distribution and migration patterns. The schooner *Pioneer* was engaged in salmon research for the entire season, leaving Seattle April 15 and returning September 1, while the schooner *Tordenskjold* was engaged in salmon research from May 23 to July 29. Prior to and following this period the *Tordenskold* was employed by the King Crab Investigation. The station pattern of the two vessels is shown in figure 1.

Operating in a vast area of the central North Pacific Ocean and Bering Sea two small vessels,

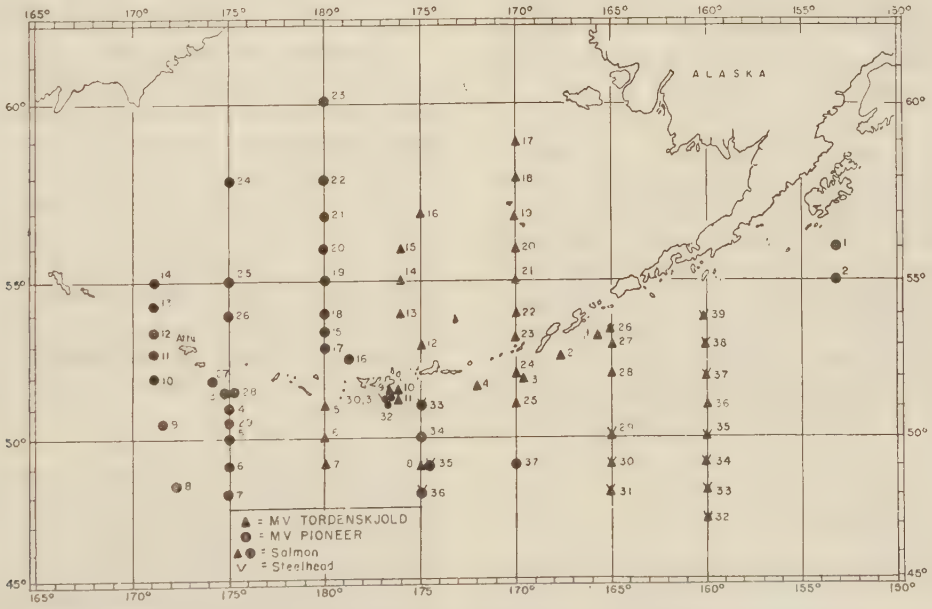

Figure 1. Chart showing the distribution of salmon and steelhead during the period of April and September, 1959, as determined by the catches of the vessels *Pioneer* and *Tordenskjold*.

each manned by a biologist, an oceanographer, and a crew of five, are not capable of the intensive, detailed study that would be necessary for a thorough understanding of the dynamics of the intermingling of North American and Asian salmons including seasonal and annual variations, and related changes in the ocean environment. We must, therefore, concentrate our efforts on those objectives which are of primary importance at the present time.

Racial Samples

In accordance with this policy we have, for the past three seasons, assigned priorities to the various scientific functions carried on aboard our vessels. Highest priority has been assigned racial sampling, particularly of whole fish and blood. To increase sample size the number of gill nets set each day was increased this year from the 24 shackles fished in 1957 and 1958 to 36 shackles. All of the increase was in $4^1/_2$ inch mesh which we find, on the average, produces our largest catch per unit of gear. Our set in 1959, therefore, included 24 shackles of $4^1/_2$ inch mesh, 4 shackles of $5^1/_4$ inch, 4 shackles of $3^1/_4$ inch, and 4 shackles of $2^1/_2$ inch mesh.

The increase in gear contributed to a substantial increase in catch. Total catch for the 1959 season was 21,498 salmon including 6,966 reds, 6,492 chums, 7,634 pinks, 317 silvers, 89 kings, and 62 steelhead. This is in contrast to a total catch of 5,462 salmon in 1958 and 12,007 in 1957 when three vessels were engaged in the program. The number of samples containing 50 or more specimens of the three major species also increased. In 1959 76 sets produced 38 samples of 50 or more reds, 33 samples of 50 or more chums, and 26 samples of 50 or more pinks. In all 76 percent of the sets produced samples of 50 or more of at least one of the major species. In contrast, of 73 sets that captured salmon in 1958, 29 or 40 percent produced 50 or more specimens of one or more of the major species and in 1957 of 99 sets 55 produced samples of a similar size. Blood samples increased in 1959 to 1,289 red and 314 chum compared with 226 red, 222 chum in 1958 and 812 red, 592 chum in 1957.

Distribution of Salmon

A rough measure of the relative abundance of salmon in central North Pacific-Bering Sea areas during the past three seasons is afforded by a comparison of catches (Table 1) made by the standard 24 shackle string (12–$4^1/_2$, 4–$5^1/_4$, 4–$3^1/_4$, and 4–$2^1/_2$ inch mesh). With little overlap in area these catches are season totals for the vessel *Pioneer* fishing on and west of 175°W. and the *Attu* and *Tordenskjold* fishing on and east of 175°W. Sets both north and south of the Aleutians are included. Numbers in parentheses indicate average catch per set.

Table 1. Comparison of high seas salmon catches

	Reds	Chums	Pinks
West of 175°W.			
1957–38 sets	1,391 (36.6)	2,818 (74.1)	2,155 (56.6)
1958–24 sets	453 (18.8)	787 (32.8)	46 (1.9)
1959–37 sets	2,307 (62.5)	1,811 (49.0)	2,580 (69.7)
East of 175°W.			
1957–37 sets	1,443 (39.1)	1,377 (37.2)	1,013 (27.4)
1958–54 sets	737 (13.6)	3,090 (57.2)	148 (2.7)
1959–39 sets	2,514 (64.4)	2,107 (54.1)	1,747 (44.8)

Arrayed on this comparative basis the figures show the low abundance of reds associated with the poor return to Bristol Bay in 1958. The substantial increase in reds in 1959 reflects both an increase in the catch of maturing fish and an increase in the abundance of juvenile, one-ocean-annulus fish south of the Aleutians.

Chums show little, if any, change in total catch between years while pink salmon catches clearly reflect the dominance of the odd year cycle. This dominance is reflected in catches east of 175°W. as well as west although to a much lesser degree.

Details of the 1959 distribution of the three major species are shown in figures 2 to 7, which show distributions and relative abundance of salmon large enough to be captured in the $4^1/_2$ and $5^1/_4$-inch nets. These include pink salmon, 2, 3, and 4 ocean-annulus reds and 4, 5, and 6-year chums. Catches are shown in two divisions, May-June and July-August. Small open circles indicate no catch; small dark circles show a catch of fewer than 5 per 100 fathoms of net; intermediate dark circles indicate a catch of 5 to 10.1 per 100 fathoms; and large dark circles a catch of more than 10 fish per 100 fathoms.

Figure 2 shows the distribution of maturing red salmon in Bering Sea and a mixture of maturing and immatures immediately south of the Aleutians. The Bering Sea distribution shown is similar to that found in previous years with the exception that relatively good catches over a broad area during the latter part of June suggests a wide distribution similar to the distribution observed in 1957. Figure 3

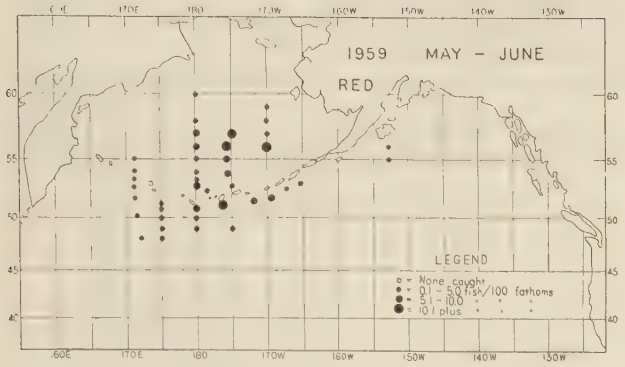

Figure 2. Red salmon abundance, May and June 1959–2, 3, 4 year ocean-age taken in $4^1/_2$ and $5^1/_4$ inch mesh nets.

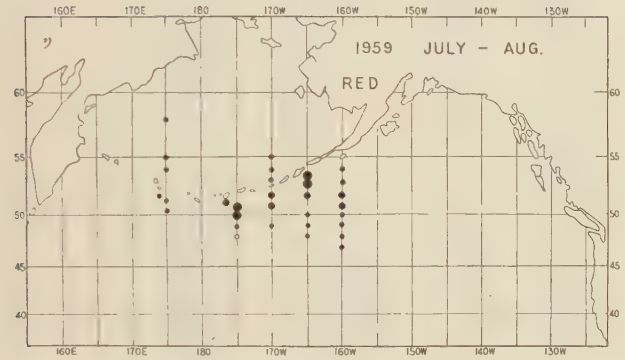

Figure 3. Red salmon abundance, July and August 1959–2, 3, 4 year ocean-age taken in $4^1/_2$ and $5^1/_4$ inch mesh nets.

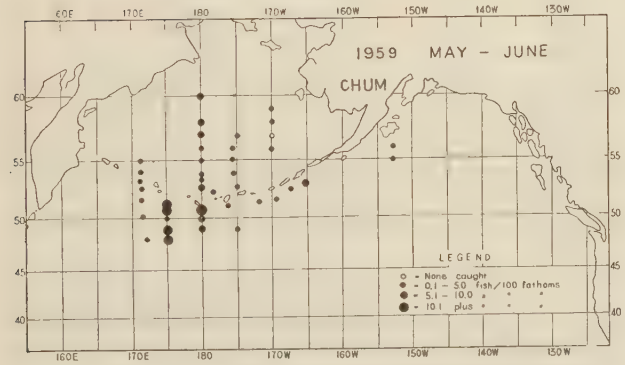

Figure 4. Chum salmon abundance, May and June 1959–4, 5, 6 year old fish taken in $4^1/_2$ and $5^1/_4$ inch mesh nets.

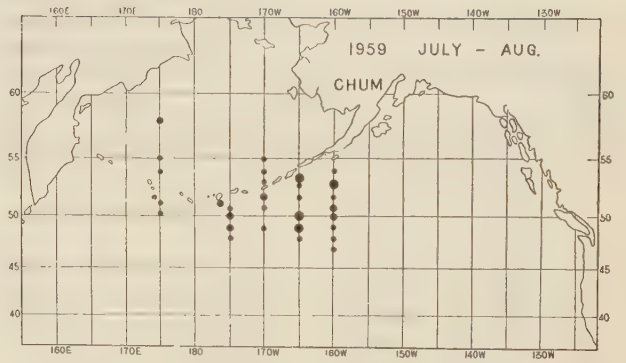

Figure 5. Chum salmon abundance, July and August 1959–4, 5, 6 year old fish taken in $4^1/_2$ and $5^1/_4$ inch mesh nets.

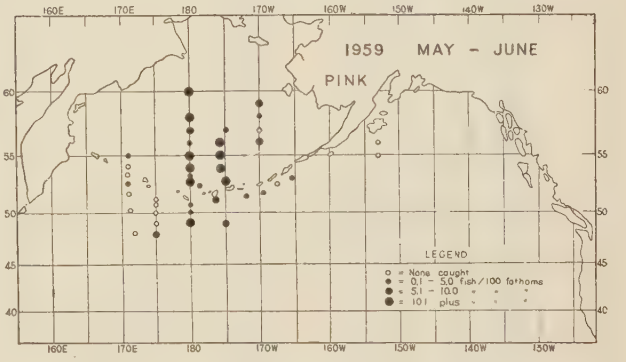

Figure 6. Pink salmon abundance, May and June 1959.

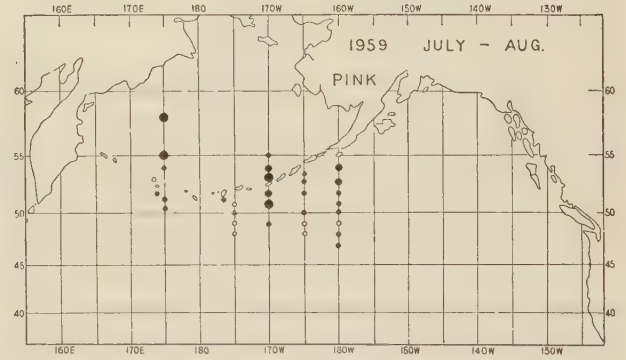

Figure 7. Pink salmon abundance, July and August 1959.

Table 2. Salmon catch by United States research vessels.

MV *Tordenskjold* May 25 through July 26, 1959

Set No.	Date	Position Lat. N.	Position Long. W.	Temp. °C	Red	Chum	Pink	Silver	King	Total	Steel-head
1	5/25	53°17′	165°35′	6.3	8	58	6			72	
2	5/26	52°40′	167°37′	5.5	1	36			1	38	
3	5/27	51°56′	169°39′	5.3	55	11	9			75	
4	5/28	51°41′	171°57′	5.5	78	31	15		2	126	
5	6/2	51°00′	180°	4.9	108	151	10			269	
6	6/3	49°49′	179°57′	5.4	23	94	10		1	128	
7	6/4	49°03′	179°56′	5.6	19	110	145			274	
8	6/7	49°01′	175°04′	5.4	22	46	91			159	
9	6/12	51°32′	176°31′	5.1	250	55	66			371	
10	6/14	51°32′	176°34′	5.3	53	15	22			90	
11	6/15	51°31′	176°25′	5.9	291	117	142			550	
12	6/21	52°59′	175°00′	5.8	38	39	225			302	
13	6/22	54°00′	176°00′	5.8	109	45	182			336	
14	6/23	55°00′	176°00′	6.2	96	38	856		1	991	
15	6/24	56°00′	176°00′	6.1	105	28	157		6	296	
16	6/25	57°00′	175°00′	6.7	119	10	29		8	166	
17	6/27	59°00′	170°00′	4.8	59	47	90		2	198	
18	6/28	58°00′	170°00′	5.0	69	11	4			84	
19	6/29	56°56′	170°06′	4.0	5					5	
20	6/30	55°59′	170°00′	6.8	202	63	79			344	
21	7/1	55°01′	170°03′	7.3	17	18	12			47	
22	7/2	53°58′	170°01′	6.6	21	32	70		1	124	
23	7/3	53°18′	170°00′	7.7	15	53	160	1		229	
24	7/4	52°00′	169°53′	8.7	239	88	121	1		449	
25	7/5	51°00′	169°56′	8.0	78	59	189	2		328	
26	7/11	53°00′	165°00′	10.0	460	531	64			1,055	1
27	7/12	52°58′	164°56′	9.7	313	29	23	2		367	
28	7/13	52°00′	165°00′	8.8	199	48	13	2		262	
29	7/15	50°02′	165°00′	8.6	38	424	3	6	2	473	7
30	7/16	49°02′	165°00′	9.1	5	168		8	5	186	2
31	7/17	48°01′	165°05′	9.9	6	48		29		83	7
32	7/19	47°01′	160°02′	10.2	1	66	1	8	2	78	2
33	7/20	48°02′	160°00′	10.2	5	46	1	7	1	60	2
34	7/21	49°02′	160°00′	10.2	20	66		7		93	8
35	7/22	49°55′	160°05′	9.9	62	182	12	6	1	263	7
36	7/23	50°57′	159°55′	10.0	137	133	32	6	3	311	
37	7/24	51°57′	159°58′	9.8	294	58	23	9		384	9
38	7/25	53°00′	160°00′	9.9	66	316	117	4	2	505	2
39	7/26	53°55′	159°40′	10.4	69	60	81	7	2	219	1
Total					3,755	3,430	3,060	105	40	10,390	48

Sets 1-4, 15 and 16 only 24 shackless were fished.

reflects the normal abundance of immature reds south of the Aleutians in contrast to a scarcity north of the Aleutians during the summer period.

Figure 4 shows the spring distribution of chum salmon of the 4, 5, and 6 year age groups. Virtually all of the chums in the larger catches in the northern Bering Sea were maturing fish as were many of those taken south of the Aleutians on 175°E. and 180°. Chums, shown in greatest abundance south of the Aleutians during the summer period (Fig. 5), were immatures with the exception of a few specimens in the set made at 54°N., 160°W. Virtually all of the chums taken at 58°N., 175°E. on July 4 were maturing fish while those taken further south on 175°E., on and after July 15, were immatures.

Table 2. (Continued)

MV *Pioneer* April 24 through August 12, 1959.

No.	Date	Lat. N.	Long.	Temp. °C	Red	Chum	Pink	Silver	King	Total	Steel-head
1	4/24	56°00′	153°00′ W.	4.9	1	1				2	
2*	4/27	55°00′	153°00′ »	4.0	17	6				23	
3	5/20	51°30′	175°03′ E.	4.8	25	182				207	
4	5/22	51°00′	175°00′ »	4.7	41	418			1	460	
5	5/23	50°00′	175°00′ »	5.0	17	42				59	
6	5/24	49°00′	175°00′ »	4.7	28	177				205	
7	5/25	48°00′	175°00′ »	5.1	35	488	102		1	626	
8	5/27	48°20′	172°08′ »	5.0	27	37				64	
9	5/28	50°25′	171°20′ »	5.0	22	19			1	42	
10	6/3	52°00′	171°00′ »	5.0	15	11			1	27	
11	6/4	52°00′	171°00′ »	5.6	16	20	4			40	
12	6/5	53°30′	171°00′ »	5.6	36	25				61	
13	6/6	54°20′	171°00′ »	4.5	56	14				70	
14**	6/8	55°00′	171°00′ »	5.0	63	18	1		5	87	
15	6/13	53°30′	180°	5.0	68	56	44			168	
16	6/22	52°38′	178°47′ W.	5.6	52	16	69			137	
17	6/23	52°59′	179°55′ E.	5.5	83	124	615			822	
18	6/24	54°00′	180°	5.6	20	23	289		1	333	
19	6/25	55°00′	180°	5.6	57	15	210			282	
20	6/26	56°00′	180°	5.6	165	39	36			240	
21	6/27	57°00′	180°	5.3	138	103	75		1	317	
22	6/28	58°00′	180°	5.6	44	105	1,282		10	1,441	
23	6/30	60°00′	180°	6.5	32	120	393		13	558	
24	7/5	58°00′	175°00′ E.	5.8	68	150	764		2	984	
25	7/15	55°00′	175°00′ »	7.2	19	98	564	1		682	
26	7/16	54°00′	175°00′ »	8.2	12	32	24			68	
27	7/19	51°54′	174°06′ »	8.5	24	20	11	9	1	65	
28	7/22	51°30′	175°00′ »	7.9	58	6	3	10	1	78	
29	7/23	50°30′	175°00′ »	9.4	58	10	3	76	4	151	
30	7/27	51°31′	176°42′ W.	7.9	475	164	37	45		721	1
31	7/28	51°31′	176°40′ »	7.2	177	63	5	10	1	256	
32	7/29	51°29′	176°38′ »	8.0	507	197	39	43	2	788	
33	8/5	51°00′	175°00′ »	10.4	367	14		4		385	10
34	8/6	50°00,	175°00′ »	10.4	358	115	3	11	2	489	
35	8/7	49°00′	175°00′ »	10.6	28	78		3	2	111	2
36	8/9	48°00′	175°00′ »	11.2	1	29				30	1
37	8/12	49°05′	170°10′ »	10.7	1	27	1			29	
Total					3,211	3,062	4,574	212	49	11,108	14
			Pioneer		3,211	3,062	4,574	212	49	11,108	14
			Tordenskjold		3,755	3,430	3,060	105	40	10,390	48
			Total		6,966	6,492	7,634	317	89	21,498	62

* Lost 15 shackles due to rough seas.

** Nets in water 40 hours due to rough seas.

We obtained an unusually good picture of the pattern of the pink salmon migration as our late-May, early-June stations on 171°E. and 175°E. were west of the body of westward migrating pink salmon (Fig. 6) and, as a result, few were taken. Late June sets on 180° and 175°W. encountered the main movement of pink salmon westward through Bering Sea. Summer catches (Fig. 7) show pinks in some abundance on 175°E. and 170°W. early in July while in late July on 175°W., 165°W., and

160°W. the catches were much smaller.

Table 2 lists gill-net sets made during the 1959 season showing date, position, surface temperature, and catch by species.

Distributions of silver and king salmon and steelhead trout are consistent with previous years. Silvers and steelhead were taken late in the season and south of the Aleutians while kings show a broad distribution which includes the Bering Sea.

Distribution of Juvenile Red and Chum Salmon

Juvenile, one-ocean-check, salmon are taken largely in $2^1/_2$-inch mesh nets in the spring and in $2^1/_2$ and $3^1/_4$-inch mesh later in the season. Figure 8 shows a scattering of juvenile red salmon, very few in number, taken in the May-June sets. Figure 9 shows the increased abundance south of the Aleutians during the summer period. Juvenile chum salmon were virtually absent from the May-June catches (Figure 10) but appeared in numbers in the July catches as shown in Figure 11.

Distributions of red and chum salmon juveniles both conform to patterns established by sampling in previous years.

Comparative Fishing

With an extensive area of the ocean to study and sample and a very limited number of vessel-days in which to accomplish the task, we have had little opportunity to evaluate fishing gear and techniques. This evaluation is important as the more we know of the variations in catch attributable to the gear used, methods of handling it, and sea conditions, the more accurately will we be able to measure the abundance of salmon.

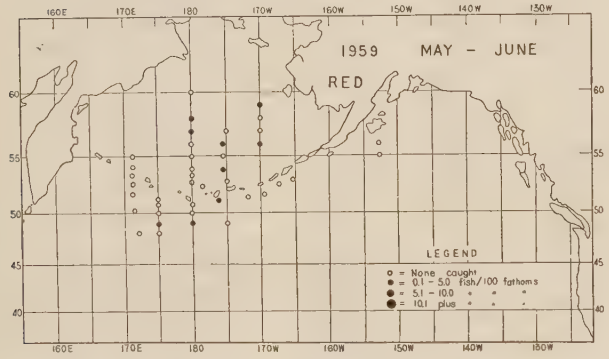

Figure 8. Juvenile red salmon abundance, May and June 1959–1 year ocean-age taken in $2^1/_2$ and $3^1/_4$ inch mesh nets.

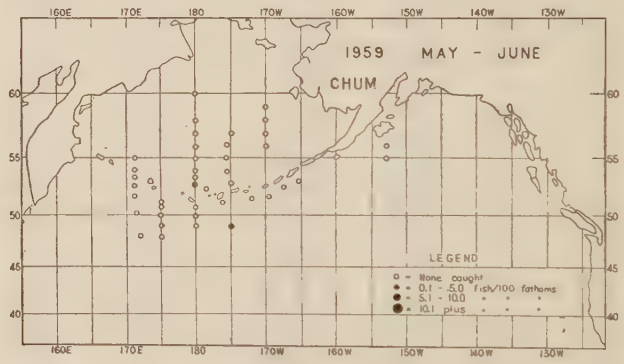

Figure 10. Juvenile chum salmon abundance, May and June 1959–2 year old fish taken in $2^1/_2$ inch mesh nets.

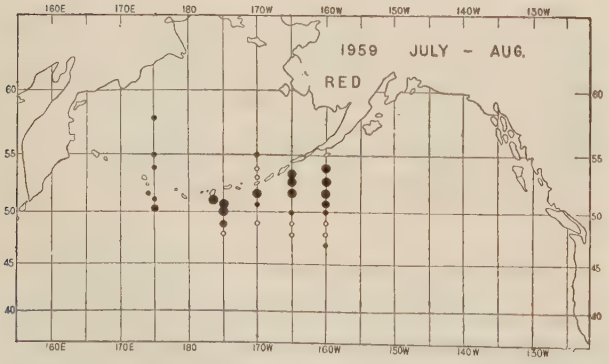

Figure 9. Juvenile red salmon abundance, July and August 1959–1 year ocean-age taken in $2^1/_2$ and $3^1/_4$ inch mesh nets.

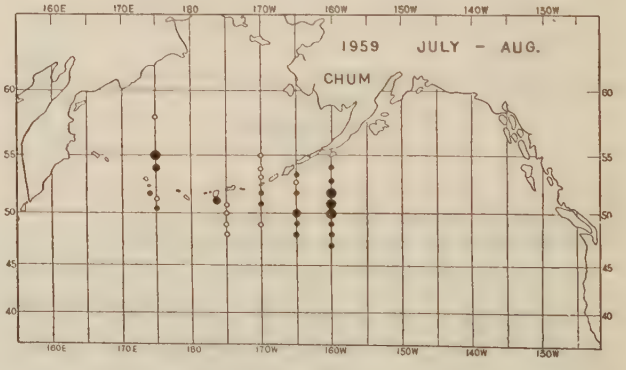

Figure 11. Juvenile chum salmon abundance, July and August 1959–2 year old fish taken in $2^1/_2$ inch mesh nets.

An opportunity presented itself this year, through arrangements with the Fisheries Research Institute and the Japanese Fisheries Agency, to compare catches made by gill net, long line, and purse seine fished concurrently and consecutively in an area south of Adak. The first comparative fishing, scheduled in June, was undertaken by the *Tordenskjold* (BCF) fishing gill nets, the *Tenyo-maru* (JFA) fishing long line, and the *Windward* (FRI) fishing purse seine. During the first three days of comparative sets by the *Tenyo* and the *Tordenskjold* sea conditions prevented use of the purse seine. A few days later however, the *Windward* and *Tenyo* were able to complete the series.

Sea conditions were more favorable during a second period of comparative fishing late in July. The second period, in the same area south of Adak, brought together the *Tenyo*, *Commander* (FRI), and the *Pioneer* (BCF). Four days were spent in fishing and exchanging samples and preliminary data. Size and age composition of the catches are among the data to be exchanged by the three agencies as they become available at a later date.

As a matter of interest, the preliminary catch data of the *Tenyo* and the BCF vessels are listed below. The *Tenyo's* catches were made by approximately four miles of long line (2,500 hooks). Gill net sets, as previously described, were 36 shackles or approximately two miles.

Table 3. Comparative long line and gill net catches.

Date	Vessel	Red	Chum	Pink	Silver	King	Total
6/12	Tenyo	22	20	4			46
	Tordenskjold	250	51	66			367
6/14	Tenyo	75	15	66		1	157
	Tordenskjold	53	15	22			90
6/15	Tenyo	16	28	19			63
	Tordenskjold	291	114	142			547
Totals	Tenyo	113	63	89		1	266
	Tordenskjold	594	180	230		0	1,004
7/27	Tenyo	111	60	8	36	4	219
	Pioneer	449	178	32	47		706
7/28	Tenyo	35	95	7	43	2	182
	Pioneer	178	63	5	10	1	257
7/29	Tenyo	91	85	5	19	2	202
	Pioneer	505	208	38	43	2	796
Totals	Tenyo	237	240	20	98	8	603
	Pioneer	1,132	449	75	100	3	1,759

From an inspection of the rough catch data it is apparent that between mid-June and late-July both reds and chums increased in the catches of both forms of gear, pinks declined, and silver salmon entered the fishing area.

OCEANOGRAPHY

As in previous years, the oceanographic observations were made from chartered fishing vessels, and the stations occupied were dependent on the fishing plan. The field work was similar to that of 1958 and consisted of hydrographic casts to 1000 meters at the location of fishing sets, and casts to 300 meters between sets, resulting in observations at approximately 30-mile intervals along the cruise track. A total of 161 stations were occupied north and south of the Aleutian Islands. The locations are shown in Figure 12.

Vertical plankton hauls from 150 meters to the surface using $^1/_2$ meter No. 6 mesh net and surface plankton tows using the modified (3′ opening) Isaacs-Kidd trawl were also made at fishing locations. This year no difficulty was experienced in towing the trawl at speeds of 6 to 8 knots and good samples were obtained. Drift bottles with attached hooks to permit capture in fishing nets were released at various locations.

Space for chemical analyses is not available on the small charter vessels and we experimented with a conductivity-thermistor cell which is towed astern of the vessel and provides a continuous record of

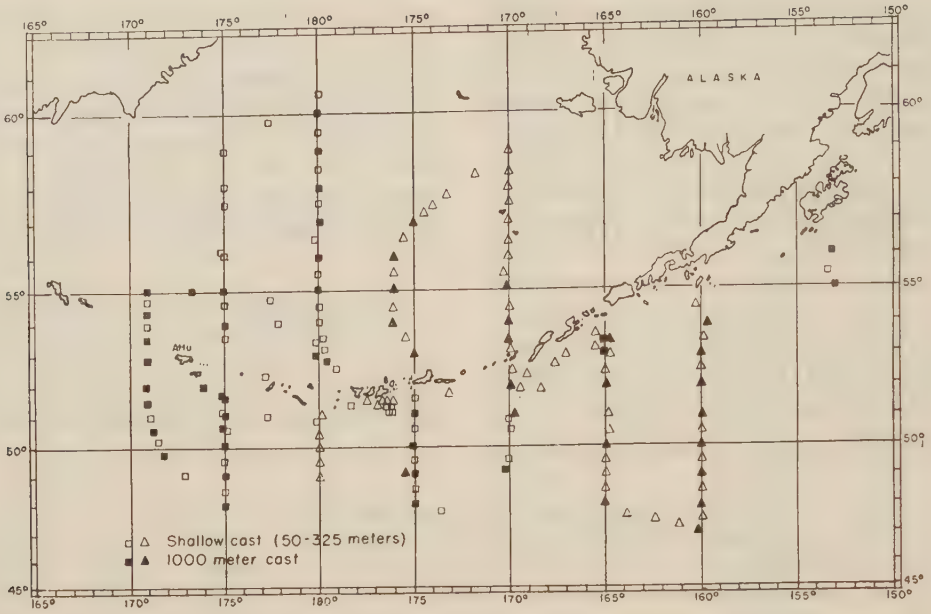

Figure 12. Location of oceanographic stations, 1959. (MV *Pioneer* □. *Tordenskjold* △)

the surface temperature and salinity. The cell, designed and constructed by the Fisheries Instrumentation Laboratory, will require further modifications and improvements before it can be considered operational.

Salmon Environment South of the Aleutian Islands in 1958

As we have gradually extended the southern limit of our observations from 50°N in 1957, to 49°N in 1958 and to 48°N in 1959 the basic structure of the subarctic water south of the Aleutians has become clarified. In summer, we are able to identify three different types of environments in the upper 300 meters which are continuous within the area of our investigations, 160°W to 175°E. Because of the fluctuations in the water properties near the surface, it is necessary to identify these environments below a depth of 50 meters. The water structure below this depth reflects the surface currents. These three environments, denoted A, B, and C, can be identified by the 33.8 parts per thousand salinity isopleth and are schematically illustrated in vertical profile by figure 13.

Region A, existing adjacent to the Aleutian chain, is characterized by extensive mixing and sinking which results in a depression of the isopleths of the various constituents. This environment is associated with the Aleutian Current which flows westward out of the Gulf of Alaska along the chain and at depth, except at the surface near the passes through the chain, is warmer, more dilute, and richer in dissolved oxygen than the environment to the south. Then too, the vigorous mixing of this water prevents the formation of a temperature minimum or sharp halocline usually found in Subarctic Water.

The second environment, Region B, is indicated by an upwelling or vertical movement of intermediate water and is shown by a rise of the isopleths resulting in a ridge or plateau-like structure. This can be considered a frontal or transition zone between the westward flowing Aleutian Current and the eastward flowing current to the south. The vertical movement establishes a shallow, sharp halocline and results in the formation of a cold stratum or tempera-

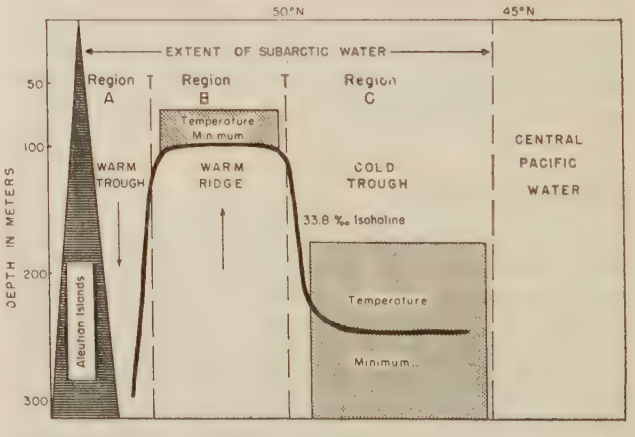

Figure 13. Model of subarctic water structure south of Aleutian Islands.

ture minimum at a depth of 75–100 meters below which the temperature rises to approximately 4.0°C. Formation of this cold stratum by winter-overturn has been discussed in previous reports. The latitudinal extent of this environment varies from approximately 150–200 miles at 160°W to 50 miles at 175°W. The absence of any appreciable longitudinal pressure gradient along the ridge from 160°W to 175°E indicates there is very little net movement of this water.

The third environment within the subarctic region, before encountering the warm, saline Central Pacific Water, is identified by a depression of the isopleths of salinity and dissolved oxygen and the presence of a cold stratum existing at 150–200 meters which is colder than the stratum existing at the shallower depth in the frontal zone. This water is flowing eastward and is believed to originate locally as a result of sinking south of the frontal zone and in the Oyashio Current, where the extremely cold winter surface temperatures permit winter-overturn to extend to a greater depth than in the Gulf of Alaska. An indication of the intrusion of this water from the westward is shown by a horizontal plot of temperatures at 100 meters constructed from data from various agencies and shown in figure 14.

Vertical profiles of temperature along 165°W in 1957, 1958, and 1959 (Fig. 15) have been constructed to show the relative positions of the two cold strata and the similarity of the temperature structure for these years. Although the presence of the cold stratum associated with the Type C environment was indicated south of 51°N in 1957 and 1958, it was not clearly identified until 1959 when observations extended to 48°N. It should be noted the temperature minimum associated with the frontal zone environment (Region B), although clearly evidenced in 1957 and 1959, was absent in 1958.

Figure 16, vertical profiles of temperature, salinity, dissolved oxygen and sigma-t along 160°W. in August 1958, clearly shows at depth the features of the three environments: the depression of the isopleths between 54°N. and the land; the predominant plateau-like feature from 54°N. to 51°N.; and the depression of the isopleths southward of 51°N. coincident with the cold stratum, (<4.0), indicated by shading.

Continuity of these three environments along the chain to 175°W. is shown in figure 17 by similar vertical profiles in July 1958. However, at this longitude the plateau-like structure has been greatly compressed latitudinally. Also evident is the presence of a vertical movement of the deeper water

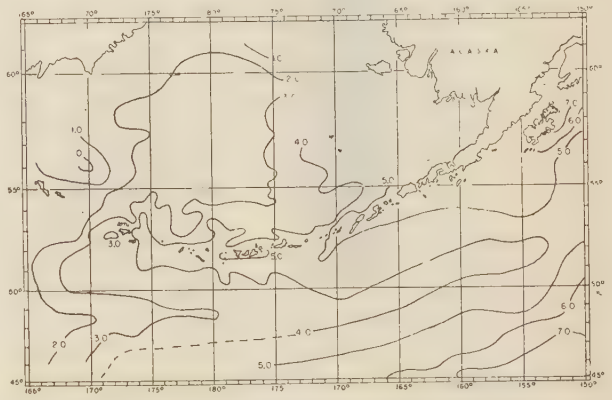

Figure 14. Temperature (°C.) at 100 meters, May– August 1958.

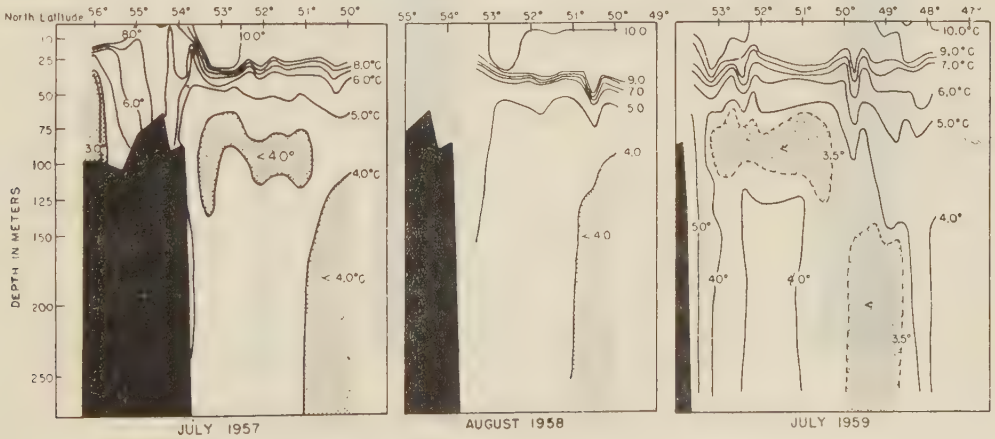

Figure 15. Vertical profiles of temperature along 165°W. (Solid black shows bottom contour).

extending to the surface which could serve to replenish nutrients to the surface layers. The oxygen maximum (part of which was supersaturated) near the surface south of the ridge implies high phytoplankton productivity.

This surface penetration ceased in August, as shown in figure 18. An intrusion of warm, dilute surface water has suppressed the ridge to a depth of 75 meters, resulting in surface conditions similar to those shown at 160°W. in figure 16. The source of this surface dilution is indicated in figure 19, a plot of salinity at 10 meters in the Aleutian area, which shows the sharp, tongue-like salinity gradient extending from the Gulf westward along the Aleutian chain.

The circulation implied by the isohalines is reflected by drift bottle recoveries. A drift bottle released in May 1958 south of the Aleutians at 175°W. and one at 180° longitude were recovered on Washington coast in October 1959 resulting in a drift of approximately 5 miles per day. The release and recovery points are shown in figure 20.

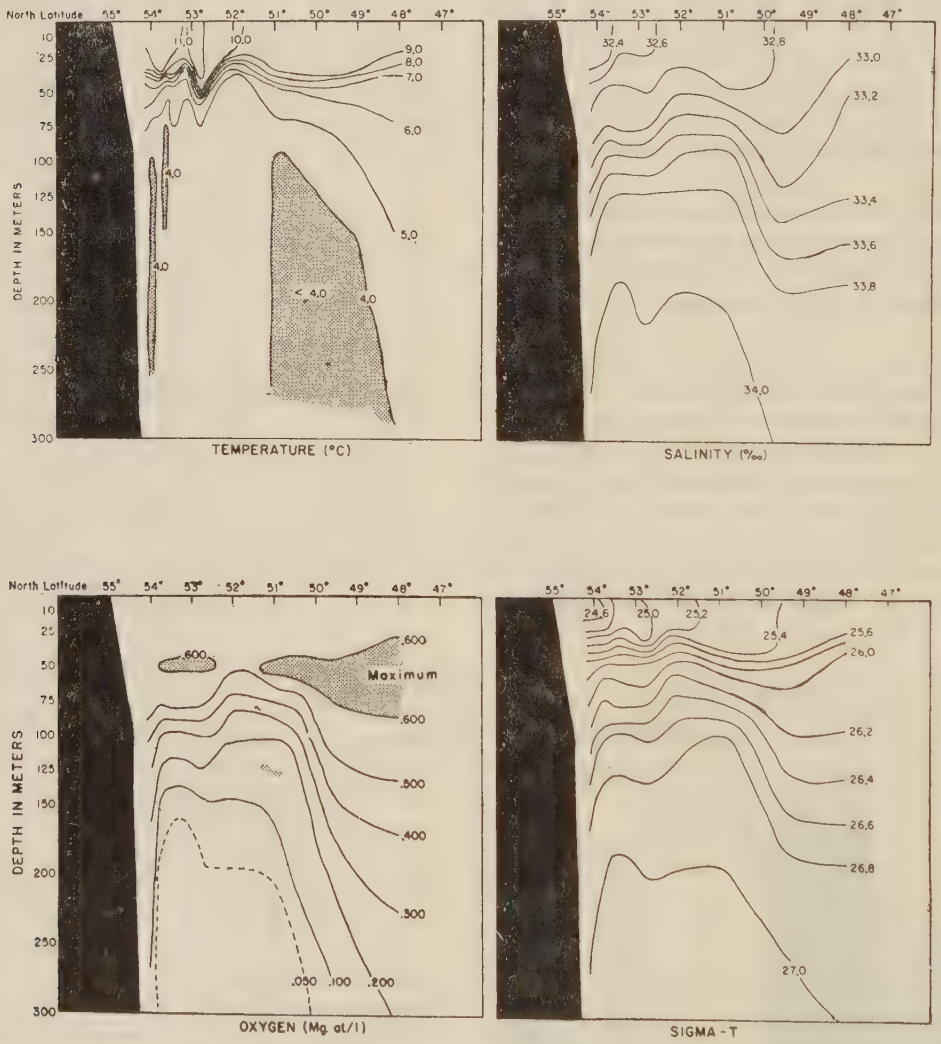

Figure 16. Vertical profiles along 160°W. in August 1958.
(MV *Pioneer*, MV *Hugh M. Smith*).
(Solid black shows bottom contour).

Although the surface features in this area are considerably altered in the summer, the basic features of the three environments are still evidenced at depth. The latitudinal extent of the three water types in 1958 are indicated in figure 21. The relationship between the vertical structure of these environments and the surface currents is seen by comparing the boundaries with the plot of the anomaly of dynamic height shown in figure 22. The surface currents relative to the 300 meter level clearly show the more intense westerly flow along the Aleutian chain separated from the eastward flow to the south by the central region in which there is little net motion.

Relationship to salmon catch

It has been shown in early spring that the region south of the Aleutian chain is a potential upwelling area serving to replenish vital nutrients to the surface layer and thus permit considerable productivity. The oceanographic ridge or upwelling area separates two current systems: the Aleutian Current to the north flowing westward along the Aleutian chain, and what must be considered an extension of the Oyashio Current flowing eastward south of the ridge. The relationship between these systems and salmon catches in May and June 1959 along 175°E and 180° has been investigated.

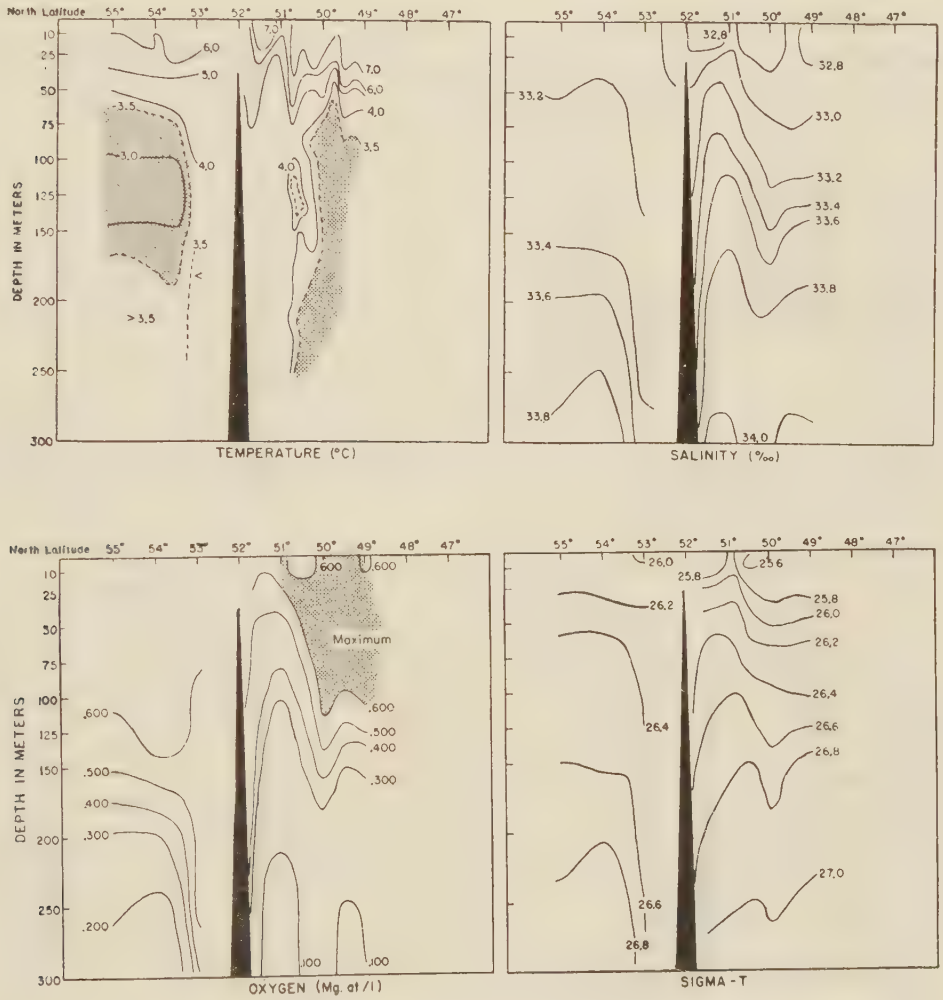

Figure 17. Vertical profiles along 175°W. in July 1958.
(MV *Pioneer*, MV *Attu*).
(Solid black shows bottom contour).

Figure 23 shows vertical profiles of temperature and salinity, and the results of the gill net fishing on 175°E in May. The thin vertical lines have been inserted at 49°30′N to denote the approximate northern edge of the eastward flowing current. Immediately apparent is the decrease in catches near the frontal zone at 49°N and 50°N of red and chum salmon compared to those at 48°N and 51°N. However, more striking is the decrease in the average fork length of the red salmon south of 49°N from the relatively constant average fork lengths of the catches to the north. The large catch of pink salmon at 48°N is of particular interest, however, later in the season large numbers of pink salmon were caught to the northward and in the Bering Sea.

Somewhat similar fishing results were obtained along 180° in June, as shown in figure 24. Southward of the superimposed line denoting separation of the current systems, the average fork length of red salmon dropped from 549.9 mm. to 445.6 mm., and the pink catch rose from 10 to 145 fish per set.

These salmon have not been identified by the various racial techniques. However, if subsequent analysis shows different stocks of red and chum salmon in these current systems, we can draw two conclusions. The absence of any major difference in salinity or temperature values at the surface implies that the direction of the current or the identity of other consituents in the water, or both, may be important factors in the distribution of salmon in this region in early spring.

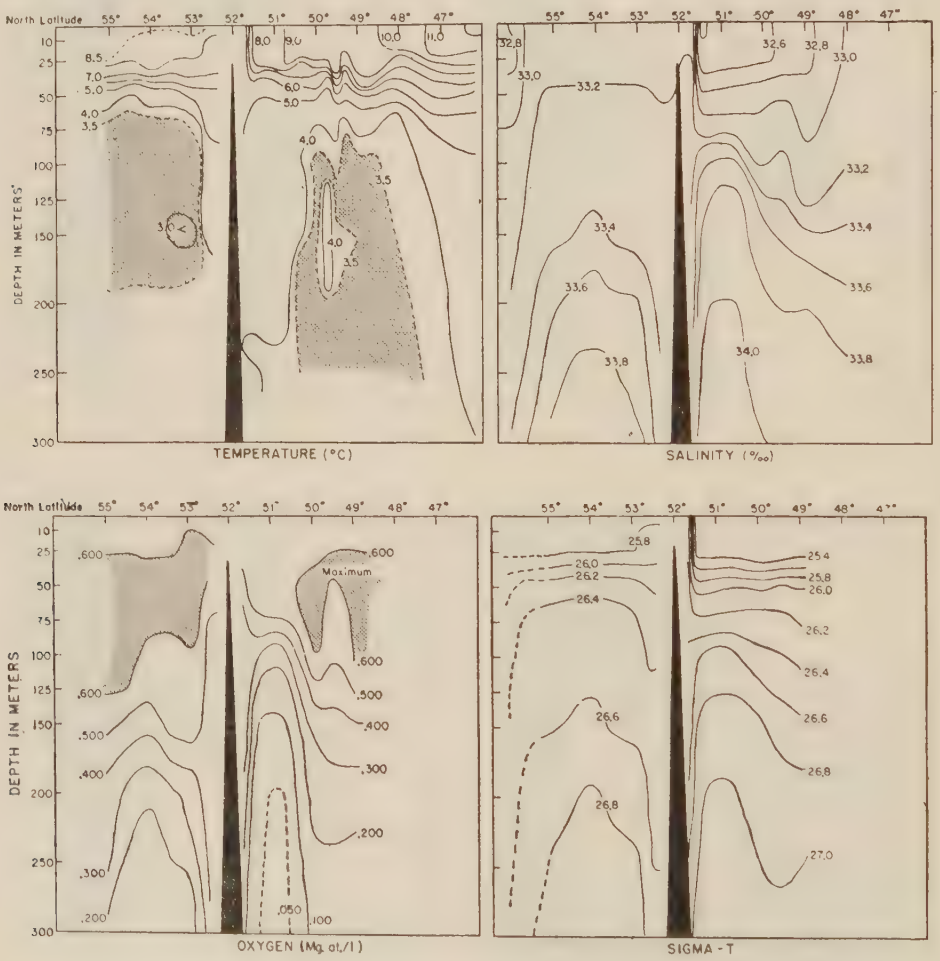

Figure 18. Vertical profiles along 175°W. in August 1958. (MV *Pioneer*, MV *Attu*, MV *Hugh M. Smith*). (Solid black shows bottom contour).

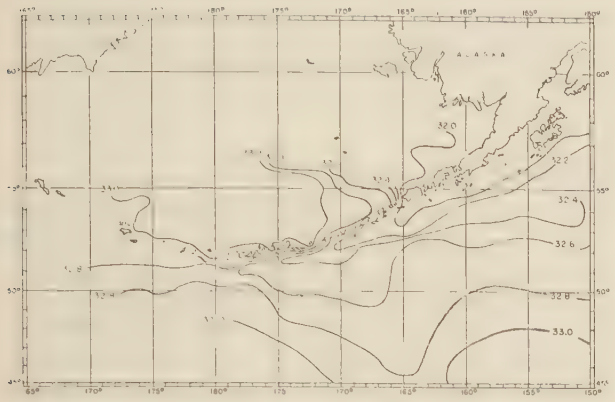

Figure 19. Salinity (‰) at 10 meters, July–August 1958.

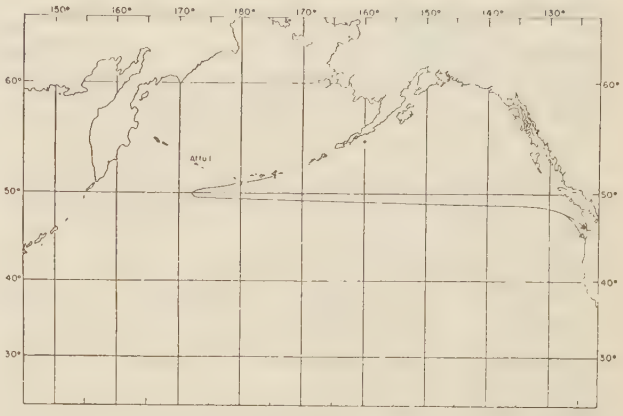

Figure 20. Drift bottles released in May 1958 and recovered in October 1959.

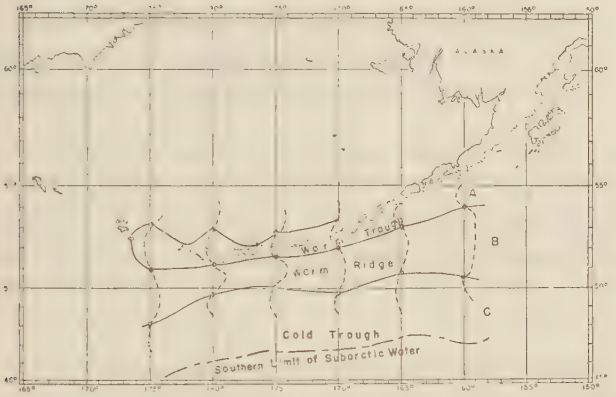

Figure 21. Approximate north-south boundaries of the three environments south of Aleutian Chain in 1958.

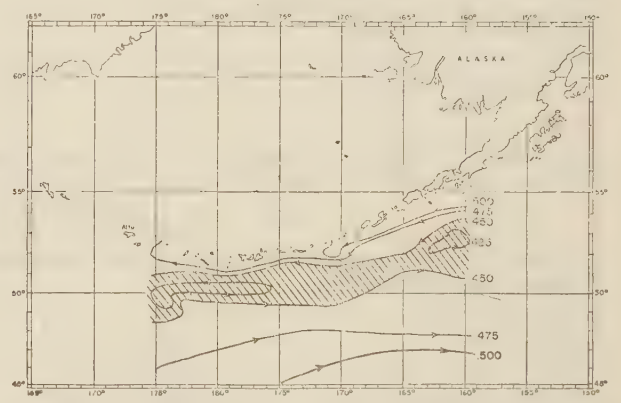

Figure 22. Anomaly of dynamic height (△ D), 0/300 decibars. (Arrows indicate direction of surface current).

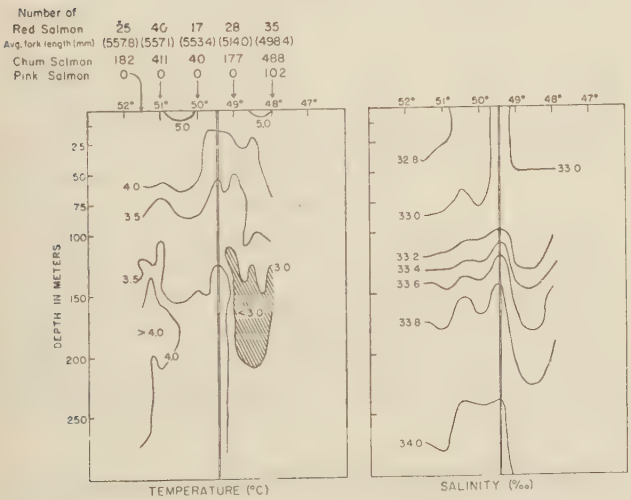
Number of
Red Salmon 25 40 17 28 35
Avg. fork length (mm) (5578) (5571) (5534) (5140) (4984)
Chum Salmon 182 411 40 177 488
Pink Salmon 0 0 0 0 102
DEPTH IN METERS
TEMPERATURE (°C)
SALINITY (‰)

Figure 23. Comparison of salmon catch with temperature and salinity profiles along 175°E. (MV *Pioneer* May 20–25, 1959).

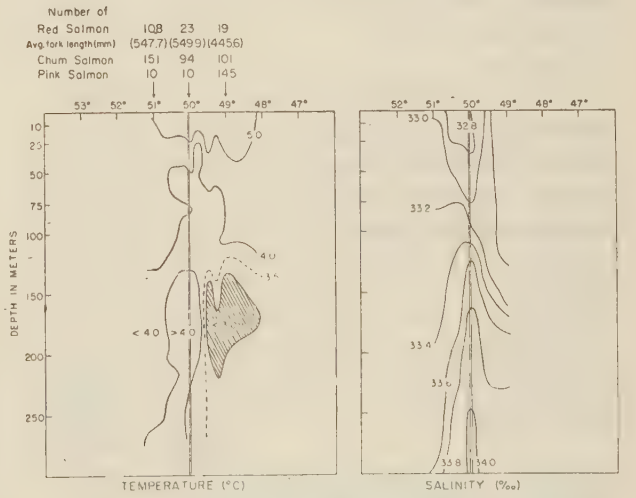

Figure 24. Comparison of salmon catch with temperature and salinity profiles along 180° longitude (MV *Tordenskjold* June 1959).

References.

Favorite, Felix and Glenn Pedersen:
North Pacific and Bering Sea Oceanography, 1957. U.S. Fish and Wildlife Service, Special Scientific Report: Fisheries No. 292 (in press).
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Pacific Oceanographic Group of the Fisheries Research Board of Canada. Physical and chemical data record, North Pacific Surveys, Western Aleutians and Bering Sea June 27 to August 14, 1958: MS Report No. 28.

Unpublished oceanographic data from the following cruises in the North Pacific Ocean:
M/V *Tordenskjold*—April–August 1959—Seattle Biological Laboratory.
M/V *Pioneer*—April–August 1959—Seattle Biological Laboratory.
M/V *Hugh M. Smith*—August 1958—Honolulu Biological Laboratory.
M/V *Oshoro Maru*—May–July 1958—Hokkaido University.
M/V *Hokusei Maru*—June 1959—Hokkaido University.

SALMON RACIAL SAMPLING

A total of 24,931 whole salmon samples and 3,660 blood samples were collected in 1959 for our racial studies. The sampling program was conducted on about the same scale as in 1958, and substantially the same numbers of whole samples were collected. Blood sample collections increased 55 percent, with red salmon blood samples making up the greater part of this increase. Tables 4 and 5 show the numbers of whole salmon and blood samples collected in 1959.

Emphasis was placed on the collection of samples from specific systems and sampling was intensified or reduced in the light of past research. Compared

Table 4. Number of whole salmon samples collected in 1959 from all areas for U.S. racial studies.

Area	East of 175°W. long.				West of 175°W. long.			
	Red	Chum	Pink	Total	Red	Chum	Pink	Total
N. American Coastal Areas								
Alaska Peninsula	374	127	209	710				
Bristol Bay	1,300	100	—	1,400				
Northwestern Alaska	250	499	75	824				
Kodiak Island	250	100	150	500				
Cook Inlet	254	116	—	370				
Pr. Wm. Sd. & Copper R.	125	101	75	301				
Southeastern Alaska	125	167	300	592				
British Columbia	500	300	225	1,025				
Canadian Research Vessels	523	512	242	1,277				
U.S. Research Vessels								
Bering Sea	341	201	320	862	1,215	1,019	1,450	3,684[1]
N. Central Pacific Ocean	1,326	1,387	530	3,243	1,977	1,977	612	4,566[1]
Japanese Research Vessels[2]					393	439	114	946
Japanese Mothership Fishery					1,237	1,000	750	2,987
Japanese Land-based Fishery					40	499	375	914
Japanese Inshore Areas					—	200	75	275[3]
U.S.S.R.								
Okhotsk					—	100	—	100
Bolshaya R.					1	100	3	104
Ozernaya R.					150	100	1	251
Totals	5,368	3,610	2,126	11,104	5,013	5,434	3,380	13,827
Grand Totals	**Red**	**Chum**	**Pink**	**Total**				
	10,381	9,044	5,506	24,931				

[1] Includes samples on 175° W. longitude.
[2] Samples from joint fishing operations not included.
[3] Numbers requested.

Table 5. Number of salmon blood samples collected in 1959 for U.S. racial studies.

Area	East of 175°W. long.				West of 175°W. long.			
	Red	Chum	Pink	Total	Red	Chum	Pink	Total
N. American Coastal Areas								
Alaska Peninsula	138	38	40	216				
Bristol Bay	175	—	—	175				
N. of Bristol Bay	43	47	16	106				
Kodiak Island	50	25	50	125				
Cook Inlet	50	17	—	67				
Pr. Wm. Sd. & Copper R.	25	25	25	75				
Southeastern Alaska	50	65	160	275				
British Columbia	50	—	25	75				
Puget Sound	25	—	—	25				
Canadian Research Vessel	25	1	—	26				
U.S. Research Vessels								
Bering Sea	107	2	—	109	363	49	51	463[1]
N. Central Pacific Ocean	252	32	6	290	567	231	2	800[1]
Japanese Research Vessels					233	42	13	288
Japanese Mothership Fishery					195	—	—	195
Japanese Land-based Fishery					—	75	75	150
Japanese Inshore Areas					—	50	25	75[2]
U.S.S.R.					25	50	—	75
Totals	990	252	322	1,564	1,383	497	166	2,046
Grand Totals	**Red**	**Chum**	**Pink**	**Total**				
	2,373	749	538	3,660				

[1] Includes samples on 175°W. longitude.

[2] Requested numbers.

to 1958, the collections of whole samples from North American coastal areas and from the Japanese mothership fishery were reduced 30 percent and 45 percent respectively. The U.S. research vessel collections showed an increase of 63 percent. In addition, a special sample of whole fish and blood samples were obtained from Soviet systems.

STUDY OF SCALES

Scientists completed the readings of the scales of the major collections of red, pink, and chum salmon for the 1958 season.

Quite an extensive series of scale samples from Siberian rivers kindly made available to us by the Japanese scientists are being studied in detail. The red salmon samples have been read and are being included in our analysis of the 1958 season. These river samples with the approximate numbers available are shown in Table 6.

During 1959 red and pink salmon scales were studied to determine the continental origin of the fish. The methods and results reported in 1958 were critically examined to evaluate the reliability of our determinations of the continental origin of salmon found in the Central Aleutian area. The variability of scale characters was tested by sex, age components, sampling date during the run and locality to establish their suitability for use in the statistical techniques employed to identify the origin of the high seas fish.

Red Salmon Scales

A method to distinguish between the fish of Asian and American origin on the high seas was developed and experimentally tested for accuracy. The method employs bivariate tables of the number of circuli in the freshwater zone and the number of circuli in the first ocean zone for the fish which migrated to sea in their second or third year. For fish which migrated to the sea in their fourth year, the actual sizes of these zones were used. The Asian fish tend to have fewer freshwater circuli and more ocean circuli.

The method was tested by using the bivariate tables to allocate to Asia or North America indepen-

Table 6. Scale samples from U.S.S.R. in 1958.

Species	River	Area	Number	
Red salmon	Bolshaya	W. Kamchatka	100	
	Dalinyaya	E. Kamchatka	170	
	Blijinyaya	»	180	
Total reds				450
Pink salmon	Bolshaya	W. Kamchatka	100	
	Icha	»	35	
	Utoka	»	70	
	Amur	W. Okhotsk Sea	290	
	Tatar	»	250	
	Kukhtui	N. Okhotsk Sea	100	
Total pinks				845
Chum salmon	Bolshaya	W. Kamchatka	100	
	Utoka	»	85	
	Kamchatka	E. Kamchatka	100	
	Amur	W. Okhotsk Sea	550	
	Kukhtui	N. Okhotsk Sea	100	
Total chums				935
Coho salmon	Bolshaya	W. Kamchatka	100	
	Kamchatka	E. Kamchatka	100	
	Kukhtui	N. Okhotsk Sea	100	
Total cohos				300
Total number of scales available				2530

dent samples for which the origin was known. An average accuracy of 91 percent was observed for the Asian fish. From the overlap in the distributions, an accuracy of 86 percent was calculated for the average of all samples used (about 2200 fish).

The distribution of Bristol Bay type red salmon in the samples from the North Pacific-Bering Sea found by applying this method is shown in figure 25 for May 1 to July 15, 1956, and in figure 26 for May 1 to July 15, 1957.

The results discussed above apply only to the areas shown. Methods for identifying the stream of origin for high seas red salmon taken east of 170°W. longitude in the North Pacific Ocean have not been devised. Because red salmon originating in some of the streams east of this meridian have scales which are almost identical to Asian fish in numbers of freshwater circuli, although they differ in the character of the first ocean zone, present techniques do not separate these fish accurately. Fish from British Columbia and Southeastern Alaska may be expected to range westward of the tip of the Alaska Peninsula.

Pink Salmon Scales

The application of discriminant function tech-

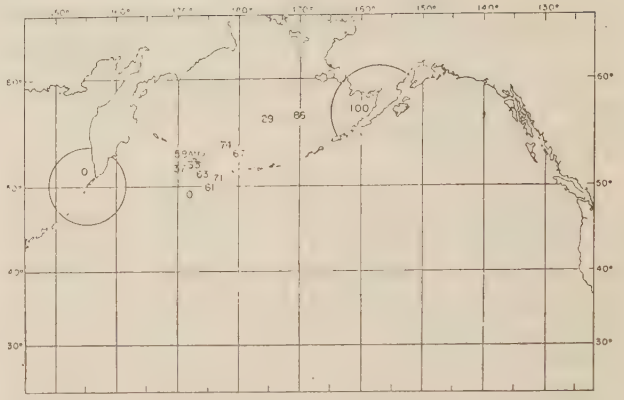


Figure 25. Corrected distribution of Bristol Bay type red salmon in samples from North Pacific-Bering Sea area, May to July 15, 1956.

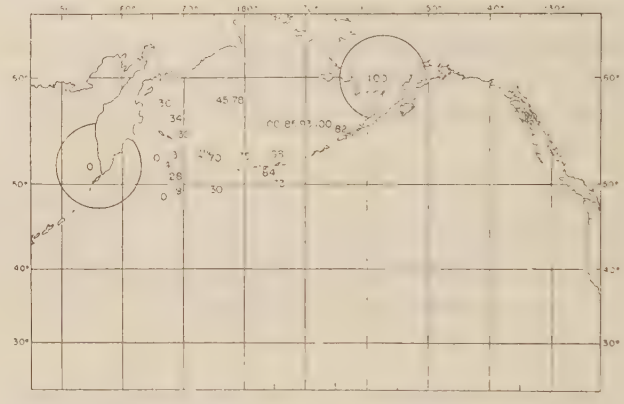


Figure 26. Corrected distribution of Bristol Bay type red salmon in samples from North Pacific-Berling Sea areas, May to July 15, 1957.

niques based on gross characters of number of circuli and size of the one complete growth zone of pink salmon scales indicates that fish from Kodiak Island and to the eastward can be separated from the Aisan and other American stocks with considerable accuracy. The more northern American stocks are not as large as the stocks east of Kodiak Island. However, some of the Aleutian stream stocks and those along the Alaska Peninsula while individually small, add up to substantial numbers. Additional research is in progress to find variations within the growth zone which will permit discrimination between the more northern American stocks and the Asian ones.

A report on a method of the determination of origin of the pink salmon using a combination of morphometric and scale characters will be submitted in early 1960.

Chum Salmon Scales

During 1959 chum scales were used only to determine the age of the fish.

SEROLOGY

Introduction

As part of the Commission's research program on questions pertaining to the Protocol, U.S. research scientists are developing and applying serological or immunochemical methods for determining the continental origin of salmon taken on the high seas. The application of these methods to the problem of determining the racial origin of salmon is based on the capacity of specific serological reactions to distinguish animals of diverse genetic backgrounds.

Red Salmon Serology

As pointed out in previous annual reports, serum antigens designated I and II have been found to occur in high frequency in blood samples taken from red salmon in North American areas and in low frequency in blood samples taken from red salmon in Asian areas. During 1959 the blood samples taken from red salmon in North American, Asian and high seas areas in 1958 were analysed for antigens I and II. The results of testing the 1958 red salmon blood samples from reference areas are presented in Table 7. It should be noted that several additional Asian areas were sampled in 1958. The frequencies found are consistent with those found in previous years; Asian areas having low frequencies of antigens I and/or II (average 11.1 percent), and North American areas possessing high frequencies (average 97.9 percent).

Because of bad weather and a lower availability of red salmon, fewer blood samples were taken by the American research vessels in 1958 than in 1957. The results of tests for antigens I and/or II on the 1958 red salmon blood samples, taken in North Pacific and Bering Sea areas by United States and Japanese research vessels are presented in Tables 8 and 9. Of 152 red salmon sampled in late May, June and July, 82 (53.9 percent) possessed antigens I and/or II (Table 8). Ninety-three immature red salmon were sampled in August south of the Aleutian Islands from 175°W. to 165°W., and from 49°N. to 52°N.; 48 of these 93 (52 percent) possessed antigens I and/or II (Table 9).

Tables 7. The incidence of antigens I and/or II in red salmon blood samples taken in reference areas in 1958.

Area	Number lacking Antigens I and II	Number with Antigens I and/or II
ASIAN AREAS		
Okhotsk Sea—1958		
51°09′ N. 153°40′ E. 6/25	9	2
50°55′ N. 153°15′ E. 7/17	14	2
East Kamchatka—1958		
58°52.5′ N. 167°15′ E. 6/19	12	2
58°56′ N. 166°57′ E. 6/20	9	2
59°18′ N. 170°38′ E. 7/31	20	0
Total	64	8
Percent		11.1
AMERICAN AREAS		
Salmon Lake (Nome)	2	23
Bristol Bay	0	192
King Cove	0	25
Karluk	4	68
Cook Inlet	0	25
Prince William Sound	2	12
Southeastern Alaska	1	70
Fraser River	0	9
Total	9	424
Percent		97.92

Table 8. The incidence of antigens I and/or II in red salmon blood samples taken by the United States and Japanese research vessels in late May, June and July, 1958.

Vessel	Set	Date	Location		Proportion with Antigens I and/or II
			Latitude	Longitude	
MV Pioneer	2	5/28	53°00′ N	178°15′ E	2/6
»	3	5/30	55° N	174° E	3/5
»	4	5/31	54° N	173° E	6/12
»	5	6/1	53° N	172° E	2/4
MV Attu	5	6/7	53°07′ N	175°02′ E	0/1
MV Pioneer	6	6/8	51°35′ N	173° E	5/6
MV Attu	6	6/9	54° N	178° W	0/1
»	7	6/16	53°30′ N	170°02′ W	1/8
MV Pioneer	8	6/18	54° N	180°	1/3
Wakashio Maru	—	6/18	56° N	172°30′ W	11/16
»	—	6/19	56° N	172°50′ W	4/6
MV Attu	10	6/24	55°04′ N	169°24′ W	7/16
»	11	6/25	55°58′ N	170°04′ W	2/4
MV Pioneer	11	7/6	51°17′ N	175°53′ W	7/13
»	12	7/7	50°30′ N	175° W	1/2
»	13	7/8	49°30′ N	175° W	1/1
MV Attu	18	7/11	52°04′ N	178°38′ W	3/4
MV Pioneer	15	7/12	50°59′ N	178°50′ W	7/7
»	16	7/13	50°18′ N	177°38′ E	4/5
MV Attu	20	7/13	53°31′ N	180°	0/3
»	21	7/14	54° N	178° E	2/3
MV Pioneer	17	7/14	49°39′ N	176°11′ E	1/1
»	18	7/15	49° N	175° E	5/7
»	19	7/16	50° N	175° E	1/4
»	20	7/17	51° N	175° E	2/3
»	21	7/18	52° N	175° E	2/3
»	24	7/21	53°07′ N	176°55′ E	1/1
MV Attu	23	7/16	54° N	175° E	1/1
»	24	7/17	55° N	175° E	0/2
»	27	7/20	54° N	174°58′ E	0/2
MV Pioneer	29	7/27	52°58′ N	175°13′ W	0/2
Total					82/152
Percent					53.9

Table 9. The incidence of antigens I and/or II in red salmon blood samples taken by the United States and Japanese research vessels in August, 1958.

Vessel	Set	Date	Location		Proportion with Antigens I and or II
			Latitude	Longitude	
MV Pioneer	31	8/5	51°30′ N	175° W	8/16
»	32	8/6	50° N	175° W	13/23
»	33	8/7	49° N	175° W	4/10
»	34	8/9	49° N	170° W	3/4
»	35	8/10	50° N	170° W	3/9
»	36	8/11	51° N	170° W	1/2
MV Attu	33	8/16	52° N	165° W	7/11
»	34	8/17	51° N	165° W	2/8
»	35	8/18	50° N	165° W	7/10
Total					48/93
Percent					52
Wakashio Maru		8/7	55° N	164° E	6/25
Percent					24

The proportion of individuals possessing these antigenic characters does not differ significantly between sets nor between groups when the samples are grouped in several ways according to time or longitude. Although this lack of difference probably is due to the small numbers of individuals sampled in each set, and thus more apparent than real, such data would seem to indicate a relatively homogeneous intermingling of Asian and American stocks of red salmon over the areas sampled.

The group of 25 red salmon blood samples, taken by the Japanese research vessel *Wakashio-maru* at 55°N' 164°E. on 7 August 1958, was from fish most of which were immature. Because of the lateness of the season, and the immaturity of the fish, this sample cannot be considered an Asian standard. Six of these 25 fish were positive for antigens I and/or II, a significantly higher incidence than in our other Asian samples (Chi-square 4.14 corrected for continuity, 1 d.f.). Among the possible explanations of this are the following: First, the sample may be one of the five out of a hundred which would not fall within the 95 percent confidence intervals. Secondly, the fish may represent some, as yet unsampled, Asian area which has a higher incidence of antigens I and/or II than those which have been sampled. A third possibility, which is of considerable importance to the Protocol problem of the International North Pacific Fisheries Commission, is that immature red salmon from American areas may migrate in measurable numbers as far west as 165°E. late in the season. Data presently available do not appear to exclude this possibility.

All of the results of testing the 1958 red salmon blood samples for antigens I and II are summarized in figure 27.

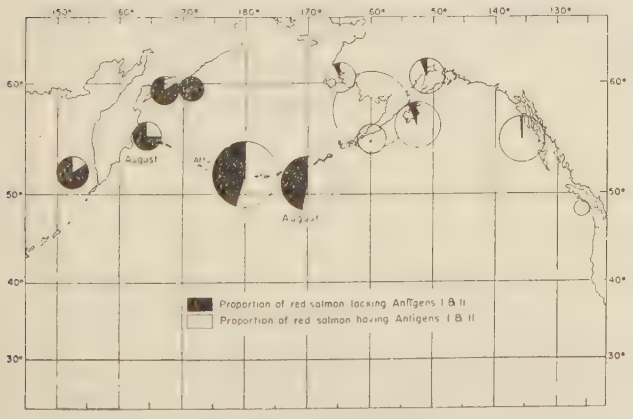


Figure 27. The incidence of Antigens I and/or II in red salmon blood samples taken in 1958.

MORPHOLOGICAL STUDIES ON RED, CHUM, AND PINK SALMON

Red Salmon Morphological Studies

In continuing the study of morphological differences between Asian and North American red salmon no new data were examined during 1959. Data previously analyzed by distance function analysis (INPFC Ann. Rept., 1958) were reanalyzed using the discriminant function analysis—a means by which individuals in a mixed sample can be classified into their constituent groups.

The discriminant function analysis, as used in our study, utilizes the value or score given by the morphological characters to classify red salmon to their native continent. In using this analysis the following approach was followed:

1. Assess the relative homogeneity of the intracontinental stocks included as reference areas.
2. Establish a series of reference samples from inshore areas into which high seas samples will be classified.
3. Construct the discriminant function assuming the following:
   a. A prior knowledge of the composition of the key stocks to be classified.
   b. The data meet the statistical requirements for use of the discriminant function analysis.
4. Test the discriminant function empirically. This was necessary because some of the tests necessary to satisfy requirement 3b were not practicable.
5. Use the discriminant function to classify 1956 and 1957 high seas red salmon samples.

Ten morphological characters were initially selected on the merits of their promise in separating various populations of red salmon within and between continents. The characters, from the left side of the fish, were as follows:

1. The number of scales along the lateral line.
2. The number of scale rows below the lateral line.
3. The position of the first haemal arch.
4. The total number of vertebrae.
5. The number of gill rakers on the ventral arm of the first gill arch.

6. The total number of gill rakers on the first gill arch.
7. The number of branchiostegals.
8. The number of pectoral fin rays.
9. The number of dorsal fin elements.
10. The number of anal fin elements.

These data obtained from the 1955, 1956 and 1957 collections were sorted by area, date of sampling age group and sex for all non-fishery stream samples.

The results of the intra-area sources of variation for red salmon are summarized in Table 10.

In general, although the number of observations in some categories was small, the consistency of the results indicates that the effects of the different possible sources of variation were properly measured.

From the results of the combined probability tests it was concluded that a confounding effect of three or four internal sources of variation occurred in the number of scale rows below the lateral line, number of dorsal fin elements and the number of branchiostegals. After these three characters were discarded, the components of samples obtained from each stream sample were homogeneous and the following statements may be made concerning the basic population unit:

1. The North American intra-continental references will be entire samples as obtained from within river systems. These reference populations may be morphologically defined by the following characters:

   a. The number of scales along the lateral line (X_1).
   b. The total number of vertebrae (X_2).
   c. The position of the first haemal arch (X_3).
   d. The number of gill rakers on the ventral arm of the first left gill arch (X_4).
   e. Total number of gill rakers on the first left gill arch (X_5).
   f. The number of pectoral fin ray elements (X_6).
   g. The number of anal fin ray elements (X_7).

2. With the populations so defined, in general within the limits of the years sampled, there were no intra-area differences in morphological characters between brood years. Pectoral fin rays exhibited some differences but further examination showed this to be of minor importance.

3. For lack of stream samples, the Asian reference areas will be the Okhotsk Sea samples morphologically defined by the same characters listed for the North American reference samples. These Okhotsk Sea red salmon are known to migrate to the major red salmon producing streams on the southwest coast of Kamchatka.

Table 10. Summarized results of tests for intra-area sources of variations, red salmon.

Character	Number of significant effects found for: Sexual dimorphism 1956	Sexual dimorphism 1957	Date of sampling 1955	Date of sampling 1956	Date of sampling 1957	Fresh-water age	Ocean age	Brood year
Scales on lateral line	1	1			1		1	
Scale rows below lateral line		2*			1	2**	4*	2*
Total vertebrae		1				1	1	
First haemal arch		1			1		1	1
Ventral gill rakers	1	1					1	
Total gill rakers		1					1	
Branchiostegals	1	2				2*	3*	2*
Pectoral fin rays	2					1		1*
Dorsal fin elements	1	2*		1		3**	2*	3*
Anal fin elements	2				1	2	1	1
Number of tests for each character	16	17	1	3	7	9	11	13

* Combination of probability test result is significant at .05 level.
** Combination of probability test result is significant at .01 level.

To evaluate the possible bias in the distribution of the meristic characters due to their association with length, (since the length composition of a sample is influenced by the type of sampling gear used), correlation of the seven characters with fish length was assessed.

On the basis of the results of these tests it seems reasonable to conclude that correlation between length and any of the seven characters is very slight or negligible (a maximum of 4% variability in the observation due to corresponding variability in length).

From a study of available red salmon catch statistics, escapement figures, tag returns and racial analysis studies using scale patterns, parasites, and blood serum as indices it seems reasonable to assume that the bulk of the samples in our 1956 and 1957 high seas collection which were collected from specific high seas regions were composed of red salmon either from Bristol Bay or from southwestern Kamchatka. On these bases the following reference areas were selected:

1. Southwest Kamchatka as represented by samples obtained from the Japanese fishery in the Okhotsk Sea for the Asian reference area.
2. Western Alaska as represented by samples from the principal streams of Bristol Bay, Chignik River (Alaska Peninsula) and Kodiak Island (Red River and Karluk River) with each sample weighted according to relative abundance as estimated by escapement to these streams.

Using the variance-covariance matrix of the seven characters for the two reference standard areas a discriminant function best separating the two areas was constructed. This function was

$$Y = .264321X_1 - .396849X_2 + .421494X_3 - .471575X_4 + .908622X_5 + 1.575538X_6 - .034089X_7$$

The mean values of the function for the two areas being

$\bar{Y}$ Western Alaska $= 70.431901$
$\bar{Y}$ Southwestern Kamchatka $= 68.184330$

The mean value of 69.308115 (Y_0) was taken as the criterion for classification as follows:

For any individual fish of a high seas sample

a. When $Y < 69.308115$ classify as being of the southwestern Kamchtka type.
b. When $Y > 69.308115$ classify as being of the western Alaska type.

D^2 for the function is 2.248. The probability of misclassification associated with this D^2 value is 22.7%.

The suitability and efficacy of the discriminant function with respect to red salmon morphological data was tested empirically by applying the calculated function based on the 1956 data on the 1957 samples from similar areas.

From the resulting frequencies of Y values above and below 69.308115 it was seen that the percent of misclassifying 1957 fish of any given population was in close agreement with the values resulting from classifying the 1956 samples from similar areas. Furthermore, the observed errors of classification for both southwestern Kamchatka and western Alaska type, 23 and 22 percent respectively, were comparable to the theoretical 22.7 percent average error of misclassification inherent to the function.

To correct for the bias introduced by the relative abundance of the constituent areas composing the high seas samples the average error of misclassification was weighted according to the relative abundance of fish as determined by escapement figures. The computed weighted average error of misclassification using the 1956 and 1957 escapement data for the western Alaska type was 17.8%. Since there was no available information on the relative abundance of the stocks contributing to the southwestern Kamchtka type the average error of misclassifying the 1957 Okhotsk Sea samples, 23.7%, was used.

In computing the number of each type of fish present in a high seas sample, a correction factor taking into account the number of each type incorrectly classified into the other was worked out and applied.

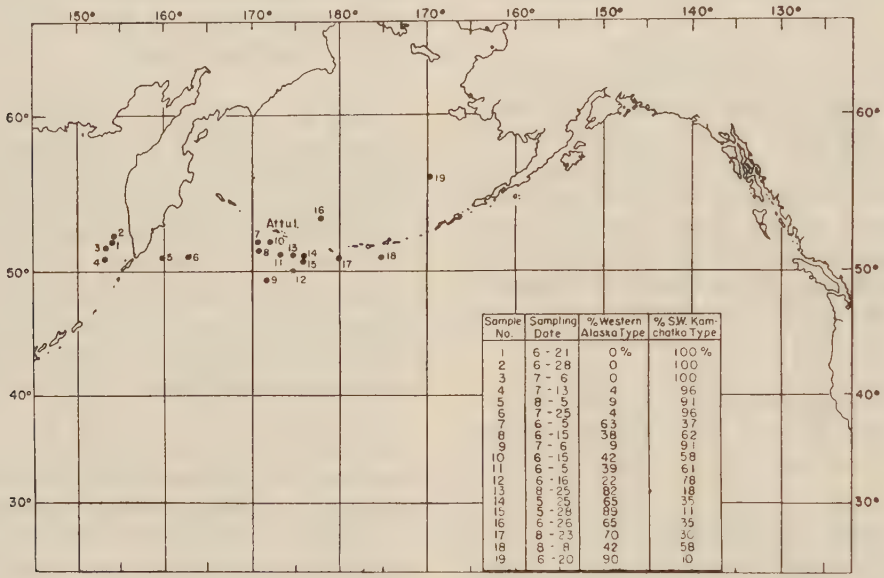
The use of the discriminant function assumes, among other things, a multivariate normal distribution of the characters and common variance and covariance. The lack of departures from normality as observed from examination of the individual frequency distributions for each character does not of itself insure that the joint distribution is normal. Similarly, homogeneity of variances or slight departures thereof, as is the case here, is not of itself sufficient to insure that the two covariance matrixes

are homogenous. However they provide a provisional verification of the method which was substantiated by empirical test of the function.

The results of classifying individual red salmon as to Asian or North American origin for the 1956 and 1957 high seas samples are shown in figures 28, 29, 30, and 31.

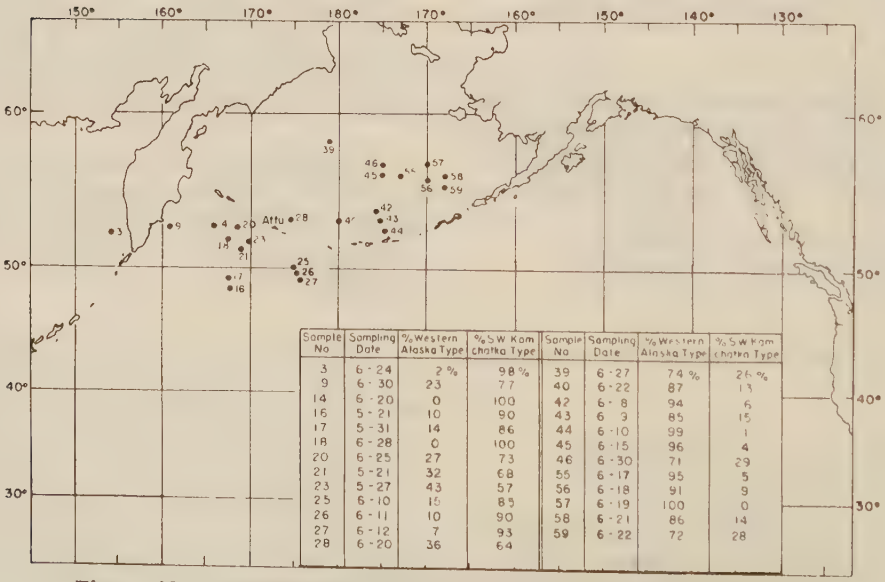
Conclusions:

1. No intra-area variation was observed to occur between sexes, freshwater age, ocean ages or brood years for North American streams examined. Therefore the basic population unit used in the subsequent analyses was the entire sample obtained from a given stream defined by the number of scales along lateral line, number of total vertebrae, position of the first complete haemal arch, number of ventral gill rakers, number of total gill rakers, and numbers of pectoral and anal fin elements.



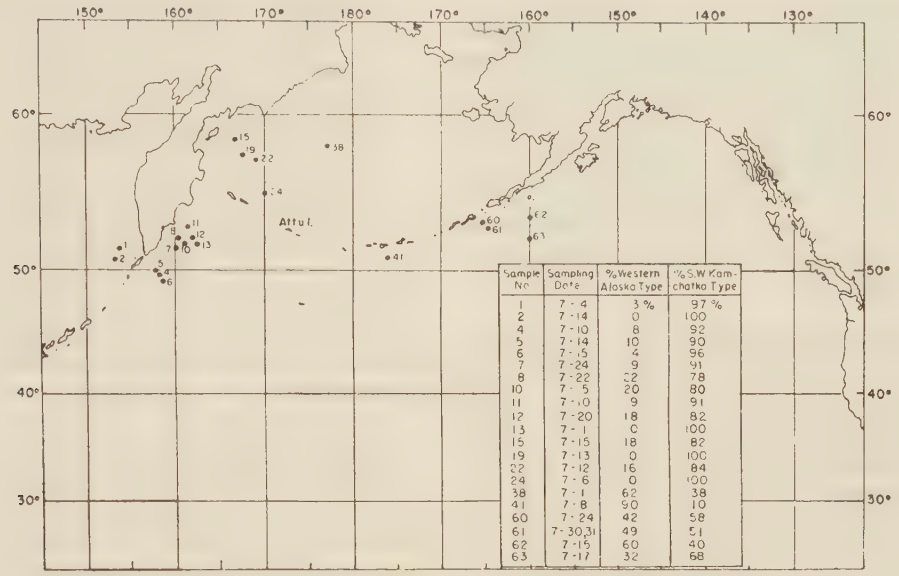
Sample No.	Sampling Date	% Western Alaska Type	% S.W. Kamchatka Type
1	6 - 21	0 %	100 %
2	6 - 28	0	100
3	7 - 6	0	100
4	7 - 13	4	96
5	8 - 5	9	91
6	7 - 25	4	96
7	6 - 5	63	37
8	6 - 15	38	62
9	7 - 6	9	91
10	6 - 15	42	58
11	6 - 5	39	61
12	6 - 16	22	78
13	8 - 25	82	18
14	5 - 29	65	35
15	5 - 28	89	11
16	6 - 26	65	35
17	8 - 23	70	30
18	8 - 8	42	58
19	6 - 20	90	10

Figure 28. Classification of 1956 high seas samples.



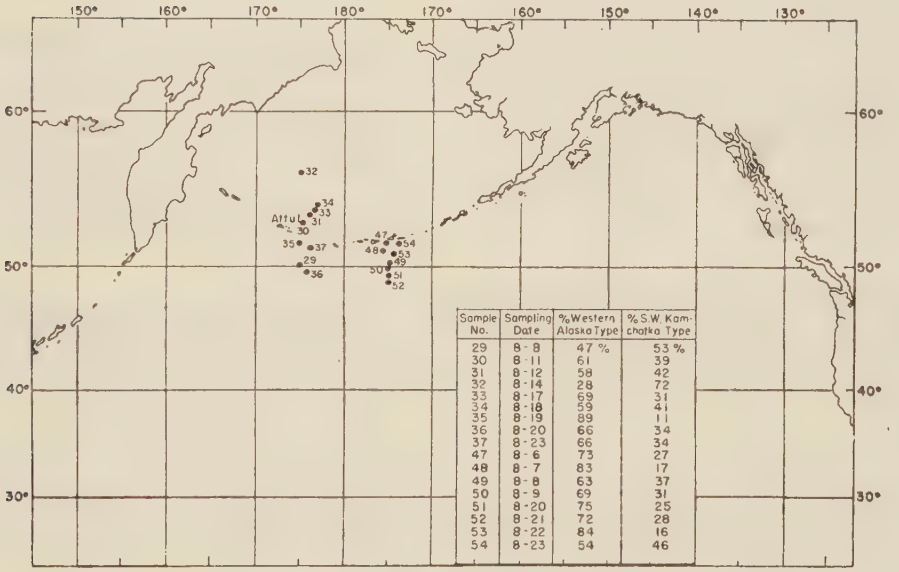
Sample No	Sampling Date	% Western Alaska Type	% S.W. Kamchatka Type	Sample No	Sampling Date	% Western Alaska Type	% S.W. Kamchatka Type
3	6 - 24	2 %	98 %	39	6 - 27	74 %	26 %
9	6 - 30	23	77	40	6 - 22	87	13
14	6 - 20	0	100	42	6 - 8	94	6
16	5 - 21	10	90	43	6 - 3	85	15
17	5 - 31	14	86	44	6 - 10	99	1
18	6 - 28	0	100	45	6 - 15	96	4
20	6 - 25	27	73	46	6 - 30	71	29
21	5 - 21	32	68	55	6 - 17	95	5
23	5 - 27	43	57	56	6 - 18	91	9
25	6 - 10	15	85	57	6 - 19	100	0
26	6 - 11	10	90	58	6 - 21	86	14
27	6 - 12	7	93	59	6 - 22	72	28
28	6 - 20	36	64				

Figure 29. Classification of high seas samples collected during the months of May and June, 1957.



Sample No	Sampling Date	% Western Alaska Type	% S.W. Kamchatka Type
1	7-4	3 %	97 %
2	7-14	0	100
4	7-10	8	92
5	7-14	10	90
6	7-15	4	96
7	7-24	9	91
8	7-22	22	78
10	7-5	20	80
11	7-10	9	91
12	7-20	18	82
13	7-1	0	100
15	7-15	18	82
19	7-13	0	100
22	7-12	16	84
24	7-6	0	100
38	7-1	62	38
41	7-8	90	10
60	7-24	42	58
61	7-30,31	49	51
62	7-15	60	40
63	7-17	32	68

Figure 30. Classification of high seas samples collected during the month of July 1957.



Sample No.	Sampling Date	% Western Alaska Type	% S.W. Kamchatka Type
29	8-8	47 %	53 %
30	8-11	61	39
31	8-12	58	42
32	8-14	28	72
33	8-17	69	31
34	8-18	59	41
35	8-19	89	11
36	8-20	66	34
37	8-23	66	34
47	8-6	73	27
48	8-7	83	17
49	8-8	63	37
50	8-9	69	31
51	8-20	75	25
52	8-21	72	28
53	8-22	84	16
54	8-23	54	46

Figure 31. Classification of high seas samples collected during the month of August, 1957.

2. The degree of correlation of the meristic characters to length of fish was negligible.

3. Samples from Bristol Bay tributaries, Kodiak Island and Chignik River and the Okhotsk Sea fishery samples were used as reference samples in the discriminant function analysis on the basis of supplemental biological evidence.

Red salmon from other areas other than the two considered (Southwestern Kamchatka and Western Alaska) appeared to occur in particular areas. Should the problem develop into one involving more than two way classification, an alternative statistic should be considered for treatment of these and subsequently collected data.

4. When samples from North American areas other than Bristol Bay, Kodiak Island and Chignik River, were classified using this function, the probability of misclassification as Southwestern Kamchatka type was much larger than with the Western Alaska reference types. Therefore, if red salmon from other North American areas were present in the high seas samples, they would mostly have been classified as Asian fish.

5. Indication of intermixing of red salmon from respective continents was evident over a considerable range, with the maximum westward extent of the distribution of North American red salmon in the Bering Sea and the maximum eastward distribution of the Asian populations occurring in the North Pacific Ocean. In general, it appears that during the month of June, a substantial percentage (greater than 70 percent per sample) of the mature red salmon in the high seas samples are North American as far west as 175°E. longitude with this percentage diminishing to 30 percent and 25 percent as far west as 168°E. longitude. Mature Asian red salmon were seen to dominate samples as far east as 175°E. longitude. For lack of samples between this longitude and 175°W., no decision can be made concerning the eastward extent of their distribution south of the Aleutian Islands.

6. The large catches of mature red salmon in the July 1957 collection were taken in the high seas waters off the coast of Kamchatka. The bulk of individuals in these samples were classified as being of Asian origin.

7. The area of origin of the immature specimens taken in July and August can be asserted with with some degree of confidence only for those portions classified into the Western Alaska type. The remaining specimens may be from Asian or North American areas other than those used in the Western Alaska reference area.

8. Sampling design must be re-examined to provide better coverage in space and time on the high seas, especially in the critical areas of intermixing, and to provide a clearer morphological definition of our inshore reference areas.

A complete report on the use of morphological differences in determining the area of origin of red salmon taken in the North Pacific Ocean and Bering Sea will be submitted in 1960.

Chum Salmon Morphological Studies

The chum salmon studies in 1959 were designed to determine the extent of variation within and between populations with respect to ten morphological characters (Table 11). Methods for determining the continental origin of chum salmon taken on the high seas and the effect of possible sampling bias due to gear selectivity by length of fish were also evaluated.

Samples of chum salmon collected from streams in 1956, 1957 and 1958 were examined to determine the extent of variation associated with differences in sex, age at maturity and brood year. None of the ten characters varied significantly with sex or age at maturity. Brood year differences were significant for the mean counts of branchiostegal, dorsal and anal fin elements. These three characters were omitted from the remainder of the analyses.

Since many samples were collected by gear selectivity by length of the fish, any character highly correlated with length would necessarily be affected by this sampling bias. The highest percentage of variation in a character attributable to length was only 2.4%. Sampling bias due to selectivity by length was considered negligible for the characters under study.

Methods of multi-variate analysis (distance and discriminant functions) were applied to the 1956, 1957, and 1958 chum salmon data. Discriminant functions were constructed which accounted for most of the variation between the Asian and North American chum salmon populations. The utility of these functions for classifying high seas chum salmon of unknown origin was empirically tested by

Table 11. List of characters utilized in chum salmon morphological studies.

1.	Number of lateral line scales
2.	Number of scales below the lateral line
3.	Number of vertebrae
4.	Number of dorsal gill rakers (1st left gill arch)
5.	Number of ventral gill rakers (1st left gill arch)
6.	Total number of gill rakers (1st left gill arch)
7.	Number of pectoral fin rays
8.	Number of branchiostegals on left side
9.	Number of dorsal fin rays elements
10.	Number of anal fin rays elements

classifying chum salmon sampled from Asian and North American inshore populations. The results indicated that the morphological differences between the populations of Central and Western Alaska and those from the Arctic and Asia were not sufficient for satisfactory identification of individual specimens from these populations. The probability of correctly classifying chums from these populations into continent of origin was about 60 percent.

Previous analyses have shown there are marked differences in scale characters for many chum salmon populations. Preliminary examination of scale characters and their applicability to multi-variate analysis is now in progress. The use of the morphological characters and scale characters combined would provide the maximum separation of Asian and North American chum salmon populations possible at the present time.

Pink Salmon Morphological Studies

The 1959 pink salmon morphological research was directed toward two objectives:

1. Determine the effects of possible within-area variation in ten morphological characters and bias in sampling.
2. Consider the suitablity of pink salmon morphological data for use in discriminant function analysis.

Samples collected in 1956 and 1957 were used to determine the extent of variation attributable to differences in sex and to obtain a measure of the effect of gear selectivity by length of fish for the following ten morphological characters:

1. Total number of vertebrae
2. Number of gill rakers on ventral arm of first left gill arch
3. Total number of gill rakers on first left gill arch
4. Number of branchiostegal rays on left side of head
5. Number of pectoral fin ray elements
6. Number of dorsal fin ray elements
7. Number of anal fin ray elements
8. Number of circuli from the focus of the scale to the annulus
9. Scale length from the focus to the annulus
10. Scale length of the first ten circuli from the focus (intermediate zone)

In order to examine the possibility of morphological differences between sexes, variance ratio tests for homogeneity of variance, analysis of variance tests of the means, and chi-square tests of the combined probabilities were performed for each of the ten characters.

No morphological character in this study ex-

Table 12. Results of variance ratio tests for homogeneity of variance and analysis of variance tests of the means between sexes with chi-square tests of the combined probabilities-pink salmon.

Locality	Characters																					
	Total vertebrae		Ventral gill rakers		Total gill rakers		Branchiostegals		Pectoral fin rays		Dorsal fin rays		Anal fin rays		Number of circuli		Scale length		Intermediate zone	
	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M	V	M
Kodiak Island (Karluk Weir) 8/22/56	–	–	*	–	–	–	–	–	–	–	–	–	–	–	NT	NT	NT	NT	NT	NT		
Northwest Alaska (Unalakleet River) 7/9/56	–	*	–	–	–	–	–	–	–	–	–	*	–	–	–	–	–	–	–	–		
Hokkaido Island (Yubetsu River) 9/0/57	–	–	**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		
Combined test	–	–	**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		

– Not significant.
* Significant at 5 percent level.
** Significant at 1 percent level.
NT Not tested. Small sample size due to scale having been absorbed.

Table 13. Classification of fish in 1957 pink salmon samples.

Area	Location	N	Percentages	
			Kodiak Is.-Cook Inlet type	Karaginskii type
*1. Puget Sound	LaConnor, Wn.	76	100.00	0.00
2. Fraser River	Gulf of Georgia fishery	65	100.00	0.00
3. Rivers Inlet		81	100.00	0.00
4. Skeena River	Tyee	82	97.56	2.44
5. Nass River	Sommerville Is.	59	98.31	1.69
6. Ketchikan	Point Eaton	97	97.94	2.06
7. Petersburg	Windham Bay	90	98.89	1.11
8. Petersburg	Tenakee	14	100.00	0.00
9. MV Key West	55°00′ N. 135°00′ W. 7/31	9	100.00	0.00
10. MV Key West	55°00′ N. 135°00′ W. 8/1	28	100.00	0.00
11. Yakutat	Situk-Ahrnklin R.	85	97.65	2.35
12. MV Key West	55°00′ N 145°00′ W	54	87.04	12.96
13. Pr. Wm. Sound	Anderson Bay 7/16	34	85.29	14.71
14. Pr. Wm. Sound	Anderson Bay 8/1	42	95.24	4.76
15. Cook Inlet	Tutka Bay	82	68.29	31.71
16. Kodiak Is.	Uyak Bay	87	79.31	20.69
17. MV Attu	53°40′ N. 165°00′ W.	13	76.92	23.08
18. MV Commander	12 mi. south Atka Is.	33	12.12	87.38
19. MV Attu	53°00′ N. 175°00′ W. 6/3	59	15.25	84.75
20. MV Attu	53°00′ N. 175°00′ W. 6/9	49	12.24	87.76
21. MV Attu	53°00′ N. 175°00′ W. 6/10	42	30.95	69.05
22. MV Pioneer	56°00′ N. 175°00′ W. 6/29	99	21.21	78.79
23. MV Pioneer	56°00′ N. 175°00′ W. 6/30	57	31.58	68.42
24. MV Commander	6 mi. S. of Little Tanaga Is.	28	21.43	78.57
25. MV Commander	8 mi. S. of Adak Is.	27	11.11	88.89
26. Kano Maru	50°05′ N. 179°56′ E.	42	21.43	78.57
27. Nippon Suisan	58°10′ N. 177°17′ E.	23	4.35	95.65
28. MV Pioneer	50°00′ N. 175°00′ E. 6/10	123	16.94	83.06
29. MV Pioneer	50°00′ N. 175°00′ E. 6/11	83	25.30	74.70
30. MV Pioneer	50°00′ N. 175°00′ E. 6/12	96	21.88	78.12
31. MV Pioneer	53°00′ N. 175°00′ E. 6/14	95	22.11	77.89
32. MV Pioneer	53°00′ N. 175°00′ E. 6/20	189	25.93	74.07
33. Kano Maru	49°37′ N. 171°00′ E.	29	20.69	79.31
34. Kano Maru	49°45′ N. 170°24′ E.	17	5.88	94.12
35. Nippon Suisan	54°51′ N. 170°24′ E.	18	27.78	72.22
36. Nippon Suisan	57°02′ N. 169°11′ E.	27	33.33	66.67
37. Nippon Suisan	51°41′ N. 167°27′ E.	24	8.33	91.67
38. Nippon Suisan	57°26′ N. 167°27′ E.	26	15.38	84.62
*39. Etsuzan Maru	49°02′ N. 167°25′ E.	86	13.95	86.05
40. Nippon Suisan	58°12′ N. 166°48′ E.	21	42.86	57.14
41. Etsuzan Maru	50°03′ N. 166°47′ E.	83	7.23	92.77
42. Nichiro	52°33′ N. 166°04′ E.	28	21.43	78.57
43. Nippon Suisan	51°39′ N. 162°16′ E.	29	13.79	86.21
44. Nichiro	52°28′ N. 161°42′ E.	51	19.61	80.39
45. Nichiro	51°39′ N. 161°40′ E.	47	21.28	78.72
46. Nichiro	52°36′ N. 161°21′ E.	49	10.20	89.80
47. Nippon Suisan	51°28′ N. 161°15′ E.	31	19.35	80.65
48. Nichiro	51°22′ N. 160°15′ E.	50	30.00	70.00
49. Nichiro	51°13′ N. 159°45′ E.	42	26.19	73.81
50. Nippon Suisan	48°57′ N. 158°30′ E.	68	35.29	64.71
51. Nippon Suisan	49°02′ N. 158°21′ E.	32	6.25	93.75
52. Nippon Suisan	49°14′ N. 158°11′ E.	27	18.52	81.48
53. Okhotsk Sea	52°08′ N. 154°15′ E.	51	9.80	90.20
54. Okhotsk Sea	51°16′ N. 153°39′ E.	81	20.99	79.01
55. Okhotsk Sea	50°52′ N. 153°28′ E.	68	16.18	83.82
56. Hokkaido Is.	Shari fishery	53	32.08	67.92
57. Hokkaido Is.	Abashiri fishery	56	30.36	69.64
58. Hokkaido Is.	Tokoro fishery	62	32.26	67.74
59. Hokkaido Is.	Yubetsu R.	62	16.13	83.87

* Numbers refer to sampling locations as shown in figure 32.

hibited consistent variation attributable to differences in sex (Table 12).

It is known that fishing gear may select fish by length. Bias in the distribution of the morphological characters employed may result if they are correlated with length.

Tests indicated that the highest percent variation attributable to length for the ten characters was only 8.7 percent (scale length). Therefore, the effect of possible sampling bias due to length selectivity is considered negligible for these characters.

To test the suitablity of morphological data for discriminant function the collection of pink salmon obtained in 1957 (Table 13, Fig. 32) was examined.

One of the assumptions made in this analysis is that the fish to be classified originated from the areas used to construct the discriminant function. Direct and circumstantial evidence was available concerning the populations which composed the majority of the high seas samples collected in 1957. The bulk of the 1957 inshore tag recoveries were made in the Karaginskii region of the Kamchatka Peninsula.

Available abundance figures show that the Karaginskii and West Kamchatka regions contributed the majority of Asian pink salmon to the high seas area. Therefore, both regions should be considered in constructing the discriminant function. Samples assumed to represent Karaginskii pinks are used in construction of the function (samples 36, 38, and 43, Table 13). Although these high seas fish were taken close to the Karaginskii area, it should be kept in mind that this may not be their area of origin. Examination of West Kamchatka pinks gave evidence that their morphological characteristics were such that the majority would be classified as Karaginskii type. This was verified when the samples from the Okhotsk Sea (samples 53, 54, and 55, Table 13), which are our best available representatives of West Kamchata pinks, were classified as 80 percent to 90 percent Karaginskii type pinks.

In the absence of any direct evidence, the selection of a North American group for use in the function was made wholly on intuitive grounds. Catches of pink salmon in 1957 in the Central Alaska District to which the Kodiak Island and Cook Inlet are major contributors, totalled about 6.5 million. This figure plus the corresponding escapement indicates a concentration of abundance which is not approached by any other North American area reasonably close to the high seas sampling area. Catch records of pink salmon show only about 3,800 (plus an unknown number for personal use) were taken in the Western Alaska District north of the Alaska Peninsula during 1957. Aleutian Island pink salmon runs are minor. Examination of the morphological relationships of other major North American areas for which we have samples indicated that their morphological relationship was such that the majority would be classified as Kodiak-Cook Inlet type pinks. This is verified in the section where samples collected from these areas are classified from 85 percent to 100 percent Kodiak-Cook Inlet type pinks (samples 1–8, 11, 13, and 14, Table 13).

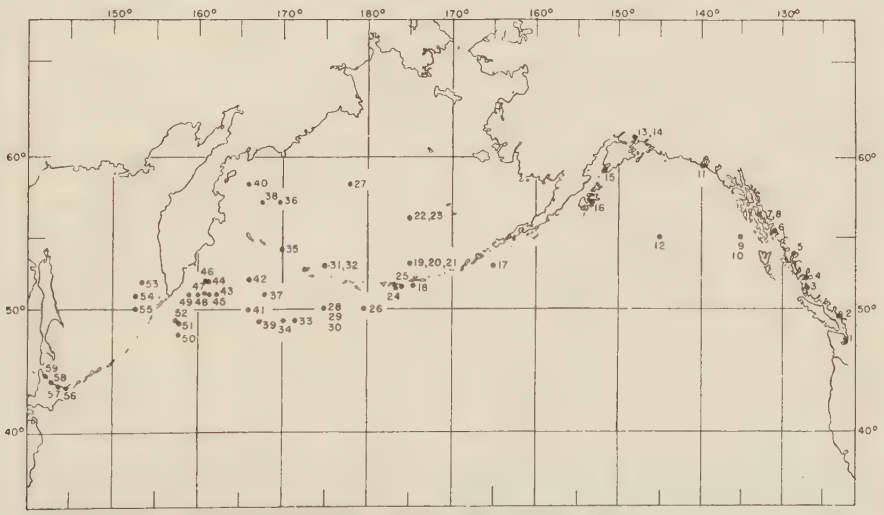


Figure 32. Sampling locations for 1957 pink salmon (see Table 13).

For the above reasons, the Karaginskii group and the Kodiak-Cook Inlet group were used to construct the discriminant function. The major contributors of pink salmon to the high seas in 1957 are accounted for either directly or indirectly in the function.

Ten morphological characters initially were considered for use in the discriminant function analysis. Preliminary analyses showed the best separators to be total vertebrae counts, lengths of the intermediate scale zone and counts of dorsal fin elements.

With the samples to be used in constructing the function and the characters to be employed established, the data were tested for conformity to the assumptions for use of the discriminant function analysis. All three characters were found to be satisfactory.

For the Karaginskii and Kodiak-Cook Inlet function, the probability of correctly classifying an individual into either of the two groups, provided the individual originated from one or the other of the groups, was found to be 72.08 percent.

Table 13 gives the results of classifying samples of pink salmon collected in 1957, in percentage of specimens in each sample resembling the Kodiak-Cook Inlet group and percentage of specimens resembling the Karaginskii group. These results indicated a complete dominance of Karaginskii type pink salmon at least as far east as 175°W. longitude (Table 13). Few high seas samples were obtained in the area east of 175°W. This lack of samples is indicative, not of a lack of sampling, but of the lack of pink salmon in the catches. The U. S. research vessel MV *Attu* fished repeatedly in June and August 1957 between longitudes 160°W. to 170°W. and latitudes 50°N. to 56°N. obtaining very few pinks. Early in June this same vessel had caught fair numbers of pinks per set along 175°W. The MV *Pioneer* fished north and south along 175°W. in late June and early July, obtaining very few pinks after having caught them in fair abundance along 175°E. in mid-June. When the MV *Pioneer* returned to 175°E. in mid-July very few pinks were obtained, apparently indicating migration of the fish toward Asia for spawning purposes. Still another vessel, the MV *Paragon* fished steadily along 175°W. from mid-August without netting a single pink salmon. It would seem unlikely that any large quantity of North American pink salmon could return from west of 175°W. without appearing in the nets of the research vessels, thus further confirming the interpretation of the results of the discriminant function analysis. Pink salmon from the Aleutian Island streams and from the Alaska Peninsula northward are indistinguishable from those of Karaginskii with the characters now utilized (Table 13, Fig. 33). If pink salmon from these areas were present in numbers in our high seas collection they would have been erroneously classified as being of Karaginskii origin. The likelihood of such an error in classification is remote for there was no evidence of large numbers of pink salmon in streams of Western Alaska in 1957. However, using this function, pinks from Southeastern Alaska and British Columbia can be very effectively separated from pinks of Kamchatka.

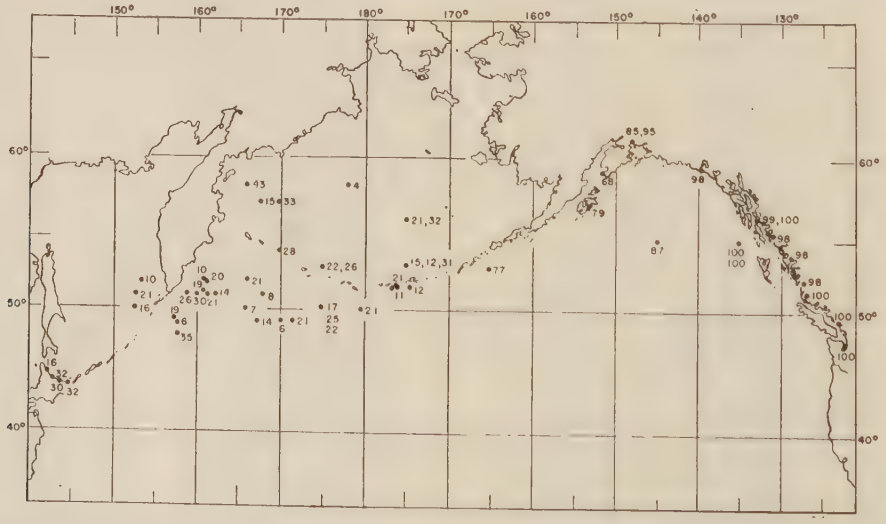


Figure 33. Percent of each 1957 pink salmon sample classified as of Kodiak Island-Cook Inlet type. Error of misclassification 27.92%.

It appears highly desirable that future collections be examined for more definitive characters to be added to those employed here in order to increase the morphological distinction between North American and Asian pink salmon.

STUDY OF MOVEMENTS BY TAGGING

The 1959 tagging research by the United States was conducted by the Fisheries Research Institute of the University of Washington, using the chartered purse seine vessels *Windward* (length 80 feet) and *Commander* (81 feet).

The *Windward* operated from March 28 through August 3; the *Commander* from May 20 through October 12. The staggered charter periods permitted fishing earlier and later than in previous years, and the overlap in schedules provided two vessels during the period when mature salmon are most available. Routh weather and mechanical difficulties greatly reduced the fishing effort early in the season.

Tagging was distributed at three principal station series; one series north and south of Attu Island (173°E) in the western Aleutians, one north and south of Adak Island (177°W) in the central Aleutians, and one south of Umnak and Unalaska Islands (168°W) in the eastern Aleutians. In addition, the vessels fished south of Kodiak Island and in the Gulf of Alaska while enroute to and from Seattle. Tagging locations are illustrated in Figure 34.

A total of 124 seine sets were made, yielding 10,793 salmon; an average of 87 per haul. This compares with an average of 73 per haul in 1958. Totals caught and tagged by species are shown in Table 14.

In all areas of fishing, seines were set in two or more directions to check the direction of movement of salmon at the time of fishing.

As in 1957, pink salmon were abundant during

Table 14. Numbers of Salmon caught and numbers tagged during 1959 season by purse seiners *Commander* and *Windward*.

Species	Red	Chum	Pink	Silver	King	Total
Number caught	4,184	3,470	2,932	42	165	10,793
Number tagged	2,915	3,162	2,870	42	146	9,135

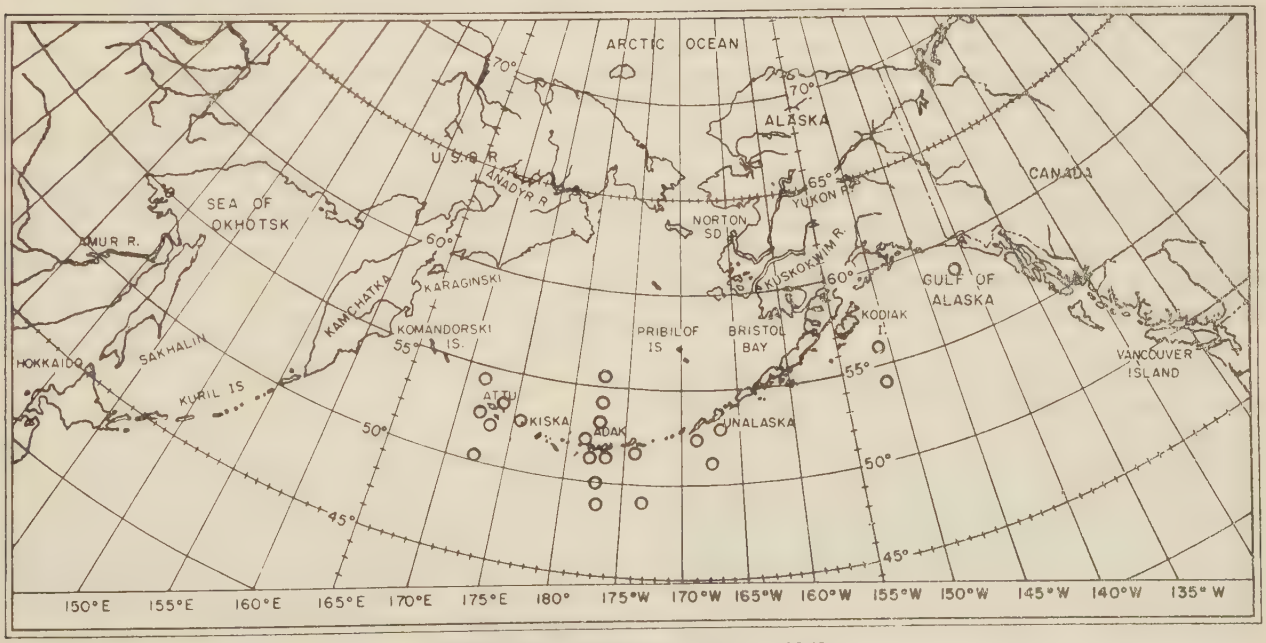


Figure 34. Tagging locations—1959.

June and early July in the Aleutian area. Immature red salmon were more numerous than in any previous year, judging by seine hauls in comparable areas. The great majority of immature reds had spent one winter at sea.

On several occasions, the purse seine vessels fished jointly with the Japanese long line vessel *Tenyo-maru* and with the U. S. Fish and Wildlife Service gill net vessels *Pioneer* and *Tordenskjold*. Results of the joint fishing, when analyzed, are expected to provide data on the relative efficiency and the size and species selectivity of the three types of gear. In addition, tag returns from long line and seine-caught salmon may be compared.

The purse seines and the fish-handling methods were similar to those described in the annual reports for 1957 and 1958 except that anesthesia[1] was used on a large scale in 1959 to reduce injury during tagging. Since injury is most serious on small **immature** salmon, the value of anesthesia cannot be evaluated until 1960 and 1961 when the immatures are expected to mature and return. Tests of anesthesia on **mature** pinks indicated no significant difference in the percentage returns between anesthetized and non-anesthetized fish (18 returns of 301 tagged using anesthesia=6.0%; 23 returns o 333 tagged without anesthesia=6.9%).

Disc tags were used in a larger proportion in 1959 because of their higher return in the past, compared with tube or " spaghetti " tags. Of 9,135 tags affixed, 5,599 were discs and 3,536 tubes. Tubes were used principally on small fish, and also on all fish tagged in the joint operations for the sake of uniformity with Japanese methods. In 1959, larger (3/4") red and white discs were tried in addition to the smaller (1/2") white discs used in the past. A preliminary check of returns indicates a much better return of the larger discs, presumably due to better visibility. It remains to be seen whether the larger discs will give better returns from immatures recovered one or two years later.

Table 15 shows the numbers tagged in 1959 according to species and tagging area. Tagging areas are illustrated in Figure 35. Numbers under species are subject to modification after species have been verified by scale reading. Approximately 185 of the 2,915 reds tagged were mature. Most immatures had spent **one** winter at sea, averaging 35.0 cm in length. Only about 600 of the 3,162 chums tagged were mature. Most immature chums, in contrast to the reds, had spent **two** winters at sea, averaging 45.0 cm in length. All pinks tagged were mature, as were all silvers tagged. Nearly all of the 146 king salmon tagged were small immatures which had spent only one winter at sea. Kings were found most abundant in areas 4A and 4B north of Adak.

Tag returns from the 1959 experiments received through December 15, 1959 are shown in Table 16. The numbers of mature salmon tagged are preliminary pending final age and maturity determinations. The 10 king salmon are shown in brackets since the maturity of this species is difficult to determine. Recoveries are listed according to the 3 principal categories: Asian coastal, high seas, and American coastal. Percentage returns of reds and chums are similar to percentages in previous years. The 5.0% return of pinks compares with 0.7% in 1956, 1.1% in 1957, and 2.2% in 1958. As mentioned earlier, the larger red and white disc tags used in 1959 apparently accounted for the increase in returns. As in 1957, pinks were recovered only on East Kamchatka or on the high seas.

Two of the reds and 3 of the chums recovered on the high seas were definitely immature at the time of tagging. The reds were only 40.0 and 41.0 cm in length when tagged. One chum measured but 30.5 cm, and the other two were 38.5 and 40.5 cm. All 5 were tagged and recovered in early July in Areas 2B and 2C near Attu Island.

Table 15. Numbers of salmon tagged by area and species-1959.

Area No.[1]	Numbers tagged by species					
	Red	Chum	Pink	Silver	King	Total
2B	3	48	59	—	3	113
2C	692	924	1,277	4	22	2,919
2D	—	2	—	2	—	4
3B	89	7	—	—	—	96
4A	17	89	146	—	68	320
4B	39	226	476	—	25	766
4C	1,948	1,494	814	30	19	4,305
4D	9	16	—	6	7	38
5C	27	62	52	—	—	141
6C	84	266	42	—	2	394
9A	—	27	1	—	—	28
9C	7	1	3	—	—	11
Totals	2,915	3,162	2,870	42	146	9,135

[1] See Fig. 35.

[1] MS-222-Tricaine Methane Sulfonate.

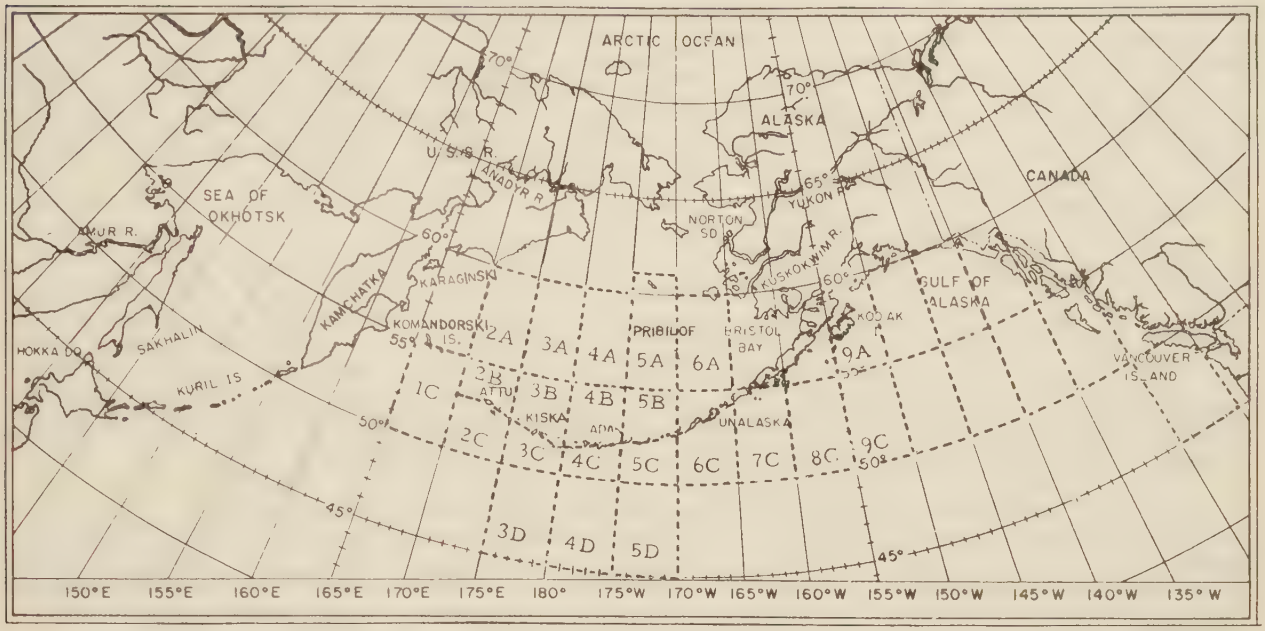


Figure 35. Numbered areas referred to in text and figures.

Table 16. Returns in 1959 of salmon tagged in 1959 (through Dec. 15, 1959).

Species	Red	Chum	Pink	Silver	King	Total
No. of *Mature* Salmon Tagged	185	600	2,870	42	(10)	3,707
Asian Coastal Returns	0	2	14	0	0	16
Percentage	—	0.3	0.5	—	—	0.4
High Seas Returns	4[1]	22[2]	129	0	0	155
Percentage	2.2	3.7	4.5	—	—	4.2
American Coastal Returns	17	7	0	1	0	25
Percentage	9.2	1.2	—	2.4	—	0.7
Total	21[1]	31[2]	143	1	0	196
Percentage	11.4	5.2	5.0	2.4	0	5.3

[1] Includes 2 reds classified as immature at time of tagging (see text).
[2] » 3 chums » » » » » .

Tag returns in 1959 from immature salmon tagged in 1958 are shown in Table 17. Additional returns from these experiments are expected in 1960. It was gratifying to see at least some returns from the small (32–40 cm) reds which had spent only one winter at sea when tagged in 1958. Previously, one-winter reds had yielded no returns.

Table 18 shows the returns in 1959 from the immature salmon tagged in 1957. Again the return of reds was gratifying, since 2 of the 3 recovered had spent only one winter at sea when tagged. The anesthesia used in 1959 should increase the return of the younger salmon in the future.

In addition to the above, one chum salmon tag from the 1956 experiments was returned in 1959. However, since the fish was 40.5 cm at tagging and only 52.0 cm at recovery, it is probable that the tag was actually recovered in 1957, but not reported by the fisherman until 1959.

The distributions of tag recoveries in 1959 are illustrated in Figures 36 through 40.

The recovery pattern of reds tagged in 1959 (Figure 36) again showed the importance of Bristol Bay reds in the Aleutian area. The lack of returns to Bristol Bay from tagging areas west of 180° was no surprise as only 8 mature reds were tagged there. Two of the recoveries by the high seas fleet were classified as mature when tagged, and 2 were im-

Table 17. Returns in 1959 of salmon tagged in 1958* (through Dec. 15, 1959).

Species	Red	Chum	Pink	Silver	King	Total
No. of *Immature* Salmon Tagged	3,661	8,207	219	3	(136)	12,226
Asian Coastal Returns	0	0	0	0	0	0
Percentage	—	—	—	—	—	—
High Seas Returns	13	30	0	0	0	43
Percentage	0.4	0.4	—	—	—	0.4
American Coastal Returns	7	7	0	1	0	15
Percentage	0.2	0.1	—	33.3	—	0.1
Total	20	37	0	1	0	58
Percentage	0.5	0.5	—	33.3	—	0.5*

* This is only a partial return of the immatures tagged in 1958, since more recoveries are due in 1960. In addition, 4 immature reds were recovered on the high seas during the 1958 season as previously reported.

Table 18. Returns in 1959 of salmon tagged in 1957* (through Dec. 15, 1959).

Species	Red	Chum	Pink	Silver	King	Total
No. of *Immature* Salmon Tagged	1,220	5,451	0	6	(113)	6,790
Asian Coastal Returns	0	0	0	0	0	0
Percentage	—	—	—	—	—	—
High Seas Returns	1	10	0	0	0	11
Percentage	0.1	0.2	—	—	—	0.2
American Coastal Returns	2	0	0	0	0	2
Percentage	0.2	—	—	—	—	0.03
Total	3	10	0	0	0	13
Percentage	0.2	0.2	—	—	—	0.2*

* In addition, 1 red and 69 chums were returned in 1958. Thus the total return of immatures was 1.2%.

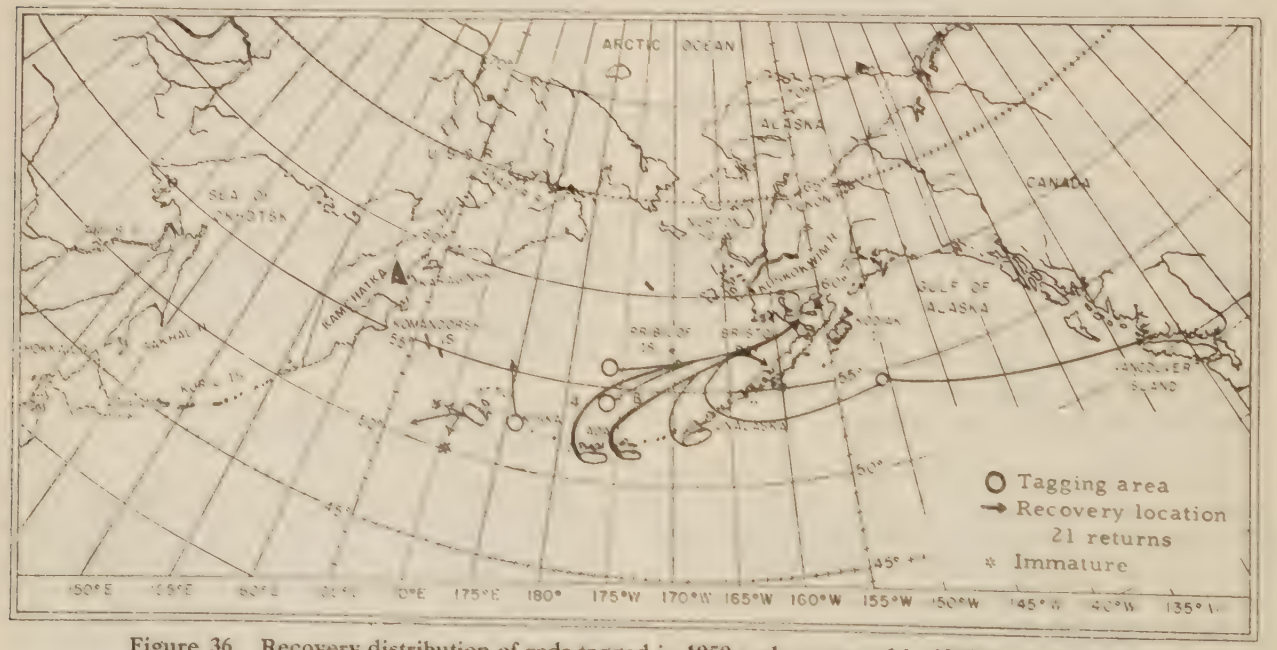


Figure 36. Recovery distribution of reds tagged in 1959 and recovered in 1959 (includes tags received through Dec. 15, 1959).

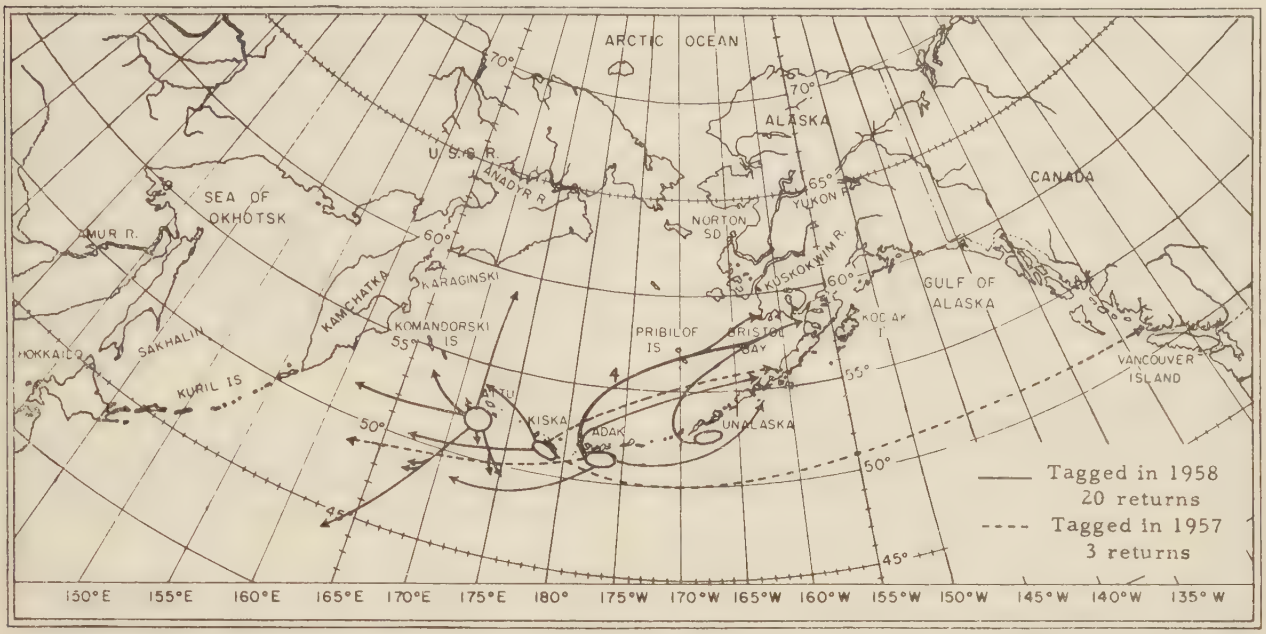


Figure 37. Recovery distribution of reds tagged in 1957 and 1958 and recovered in 1959 (includes tags received through Dec. 15, 1959).

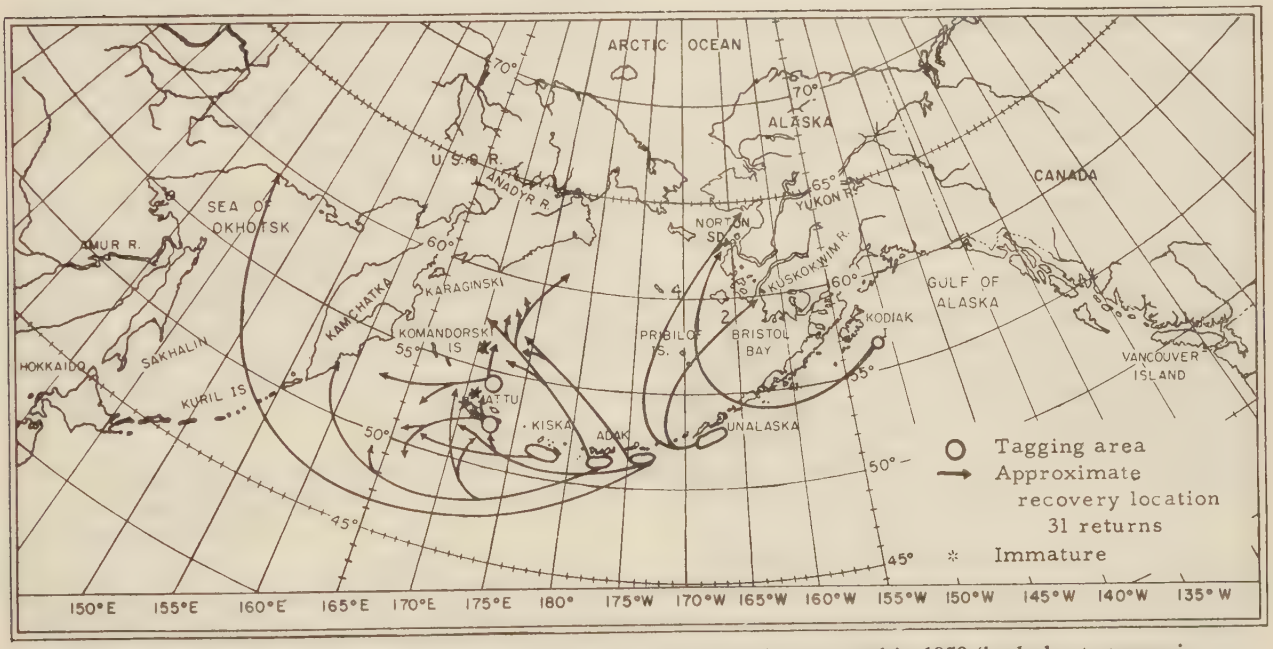


Figure 38. Recovery distribution of chums tagged in 1959 and recovered in 1959 (includes tags received through Dec. 15, 1959).

mature as previously discussed. The latter are identified with an asterisk in Figure 36.

The wide dispersion of returns from the one tagging location in the Gulf is interesting to note (Figure 36). Seven reds tagged from a single seine catch yielded one return from the Naknek River in Bristol Bay, and one from Johnstone Strait, B. C.

The returns in 1959 of immature reds tagged in 1957 and 1958 are shown in Figure 37. The return to Rivers Inlet, B. C., from near Kiska (177°E) is the longest red salmon migration seen to date, being well over 2,000 nautical miles.

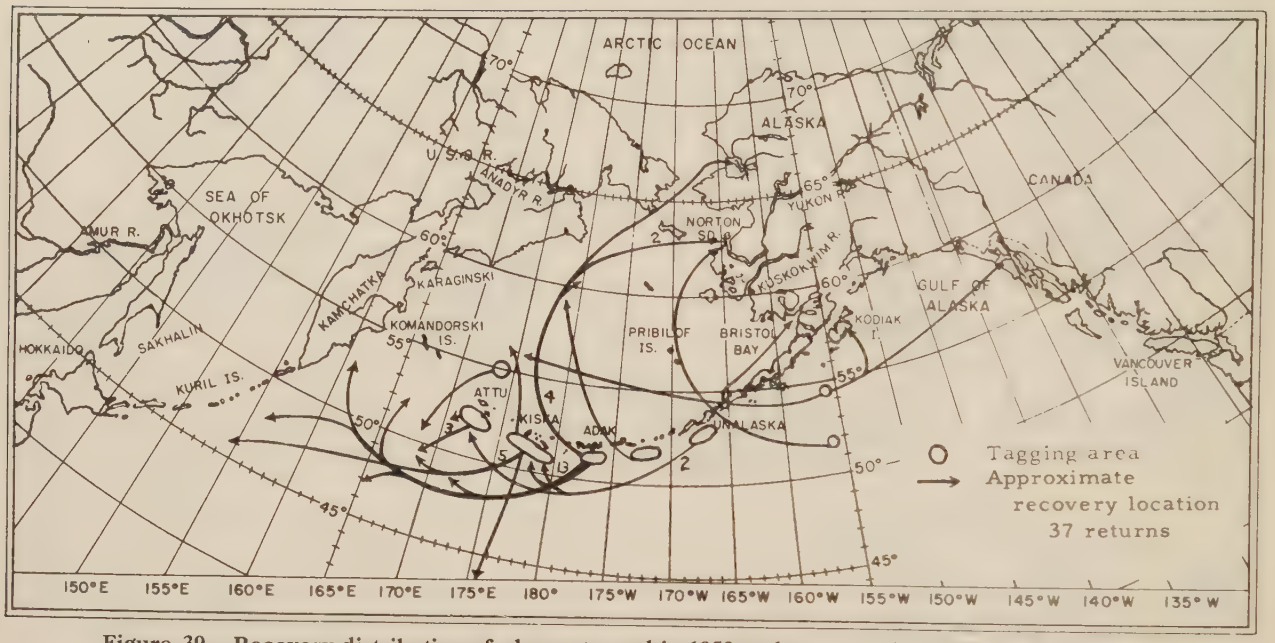


Figure 39. Recovery distribution of chums tagged in 1958 and recovered in 1959 (includes tags received through Dec. 15, 1959).

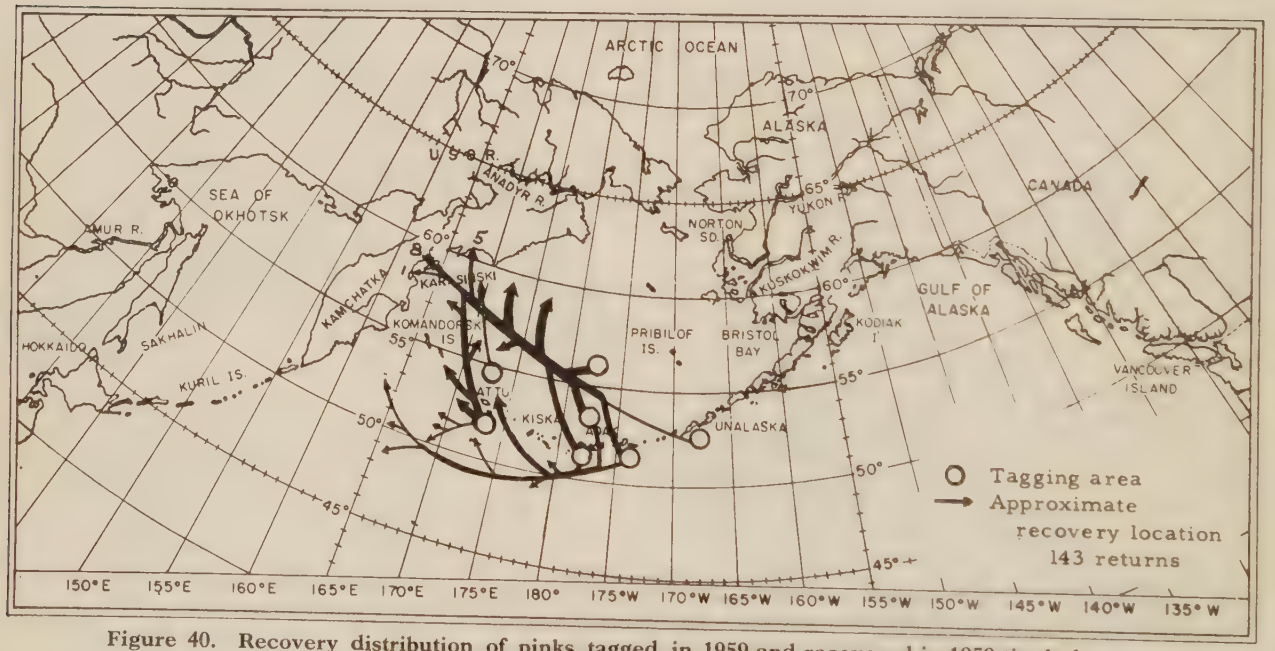


Figure 40. Recovery distribution of pinks tagged in 1959 and recovered in 1959 (includes tags received through Dec. 15, 1959). (High seas returns generalized for simplicity).

Since nearly all immature reds tagged in the 1958 experiments had spent only one winter at sea when tagged, the returns in 1959 were mostly two-winter fish, and additional returns may be expected in 1960 as three-winter fish. For this reason, the returns in 1959 from the high seas were not necessarily maturing that year.

Chum salmon returns from the 1959 experiments showed the usual recovery pattern, as seen in Figure 38. The three which were definitely immature at tagging are marked with an asterisk. The migration to the Yukon River from the Gulf of Alaska extends the known migration of Yukon chums.

The recovery distribution in 1959 of chums tagged as immatures in 1958 is shown in Figure 39. High seas recovery locations in the vicinity of 50°N and 170°E are approximated to reduce the number of intersecting lines. The distribution is similar to that of previous years except for the new results from the Gulf of Alaska. Three chums tagged in the Gulf were recovered in the Bering Sea (high seas, Yukon River, and Bristol Bay). In addition, one chum from the Gulf experiments was recovered on Kodiak Island, and one in Southeast Alaska (Taku River).

The ten chums recovered in 1959 from the immatures tagged in 1957 (Table 18) are not illustrated since all were recovered at sea in the area south and west of the western Aleutian Islands.

The distribution of pink recoveries (Figure 40) is very similar to that seen in 1957 (Figure 21, p. 82 INPFC annual report for 1957). Again, the purse seine catches showed a strong westward movement of pinks in all areas of fishing. Of the 143 returns received through December 15, 1959, 14 were from the Karaginskii area as shown and 129 from the high seas. Because of the large number of high seas returns, locations are shown diagrammatically. The width of the arrows indicates approximately the relative numbers of returns in each general location.

One silver salmon tagged in Area 4C (Figure 35) south of Adak in July, 1959, was recovered in the Kuskokwim River in August, 1959. Another silver tagged in the Gulf of Alaska as an immature in 1958 was recovered by a troll fisherman off Depoe Bay, Oregon, in June, 1959. The latter was a fortuitous recovery since only 3 immature silvers were tagged in 1958.

One steelhead tagged in the Gulf of Alaska in August, 1958, was recovered in the Samish River, Washington, in March of 1959.

Addendum to Tagging Report

Since the preparation of the foregoing report, 55 tags were received from Russia. Table 19 shows the 53 recovered in 1959 by species and by year of tagging. In addition, one tag was returned from a pink salmon tagged and recovered in 1957, and one from a chum tagged in 1957 and recovered in 1958.

The one red salmon recovery is the first return of this species from the Asian coast from our high seas tagging. The fish was tagged June 13, 1958 south of Attu Island, and recovered July 13, 1959 in Kamchatka Bay, East Kamchatka.

The 27 chums recovered in 1959 were from various points along the north and west shores of Okhotsk Sea, from West Kamchatka, and from East Kamchatka. The 25 pinks were from East Kamchatka, mostly from the Karaginskii region. Two pinks were recaptured further north (Lake Maino Pylgino) just west of Cape Navarin (62°20′N).

The additional pink recovered in 1957 was from the Karaginskii area, and the chum recovered in 1958 was from the northern Okhotsk coast.

Table 19. Salmon tags recovered in USSR in 1959 and returned too late for inclusion in preceding figures and tables.

	Red	Chum	Pink	Total
Tagged in 1959	0	11	25	36
Tagged in 1958	1	8	—	9
Tagged in 1957	0	8	—	8
Total	1	27	25	53

KING CRAB INVESTIGATIONS

Research designed to provide the International North Pacific Fisheries Commission with the facts necessary to determine the need for joint conservation measures of the eastern Bering Sea king crab stock is continuing along lines presented in past reports.

The field work, done primarily aboard chartered fishing vessels, featured otter trawling at a series of stations at 20-mile intervals throughout a 25 to 30-thousand square mile area which appears to encompass the major distribution of this stock of crabs (Figure 41). Data relating to growth, abundance, and environmental conditions were collected and the crabs caught were tagged.

During the summer of 1959 the 66-foot-long halibut schooner *Tordenskjold* was chartered jointly for use in king crab and salmon studies. Adverse weather conditions in the spring hindered the king crab program necessitating a reduction in the original 77 stations planned. Forty-two stations were occupied during the period. Following two months of salmon sampling, the *Tordenskjold* was reassigned to the king crab investigation in August. Mass tagging at widely spaced areas was emphasized during the second phase of the 1959 field season.

Tagging operations for growth, migration, abundance and degree of mixing studies have prog-

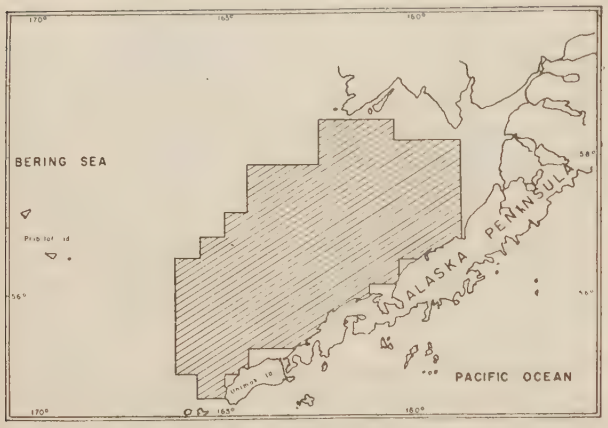


Figure 41. King crab sampling area.

ressed as shown in Table 20.

A major portion of the tag recoveries was made by the Japanese Fisheries Agency and was returned with very complete data. Much appreciation is expressed to Mr. Seiwa Kawasaki, biologist aboard the king crab factory-mothership and to the Japan Fisheries Agency for their cooperation and completeness of recovery information.

Included in the tag returns are 325 male crabs ranging in size from 96 to 169 millimeters in carapace length which show evidence of having moulted. The mean carapace length growth increment per moult was calculated to be slightly less than sixteen millimeters.

Examining the shell condition of every male crab sampled throughout the station pattern provides us with a percentage of crabs of each size that moulted during the sampling year. Then, combining the percentage moulting with the growth increment per moult, we have developed the average growth rate estimates shown graphically in Figure 42.

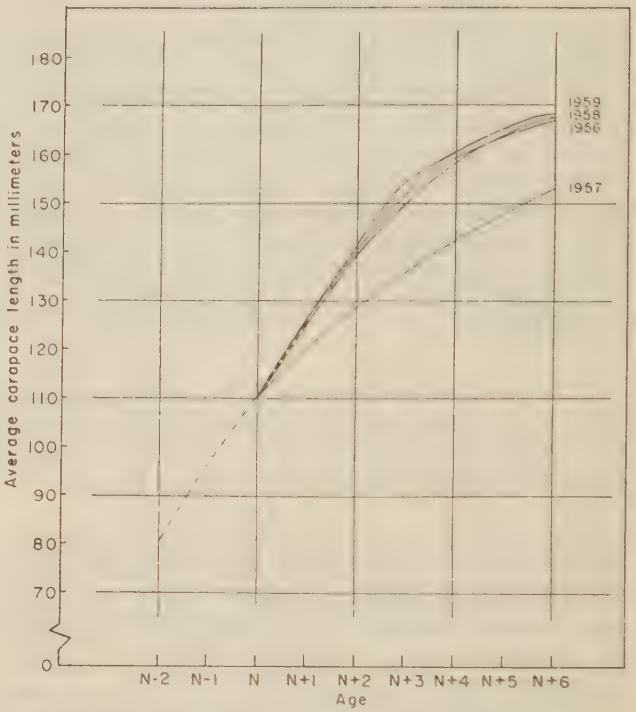


Figure 42. Average growth curves of the adult male king crab for each of the years 1956 through 1959 as determined from modal progression in size frequency distributions (broken line) and population models (solid lines).

The growth curves calculated from the observed proportions moulting in 1956, 1958 and 1959 are quite similar. The 1957 data, however, suggests a much lower rate, principally due to the lesser frequency of new shell crabs observed in the sizes from 110 to 150 millimeters. The cause for this apparent anomaly is not known. However, realizing the possibility of mis-classification of shell condition, we developed more definitive criteria after the 1957 season.

Table 20. Bering Sea king crab tagged and recovered.*

Tagging year	Number released	Recoveries during						
		1954	1955	1956	1957	1958	1959	Total
1954	1,107	44	60	1	2	1	0	108
1955	1,351		32	53	35	18	12	150
1956	4,063			53	197	114	65	429
1957	13,795				39	192	214	445
1958	9,851					40	109	149
1959	4,447						36	36
Total	34,614	44	92	107	273	365	436	1.317

* The table is presented only to show the magnitude of releases and recoveries. Since each year's tagging experiment varied in sexes, sizes and area, the data are not directly comparable.

To supplement growth determination from the above method, and to extend the estimated growth rates to smaller sizes, the progressions of modes in size frequency distributions taken in the past five years were examined.,The extension of the growth curve is included in Figure 42. The results by both methods are encouraging by their similarity and a report describing the growth of the eastern Bering Sea adult male king crabs has been completed.

A report describing the growth of small crabs in Unalaska Bay is also being prepared. Crabs were sampled by skin diving biologists at approximately four-month intervals from May 1958 through May 1959. The growth rate of one and two-year-old crabs was then resolved from the progression of modes in repeated size frequency distribution samples. The data show a mode progressing from 13 to 39 millimeters during the sampling period. Another mode appears at 5 millimeters in September and increases to 12 millimeters in May 1959 (Fig. 43). We interpret the 5 millimeter group sampled in September to be made up of crabs hatched in the spring of 1958. The 12 and 13 millimeter crabs caught in May 1958 and 1959 are interpreted to be of age one, and the 30 millimeter crabs two years of age.

The small crab studies also provided us with 318 moulting observations ranging in carapace length from 4 to 80 millimeters. An average growth increment per moult of 25 percent of their original size was observed and indicated that the previously mentioned progression from 13 to 39 millimeters is the result of five moults.

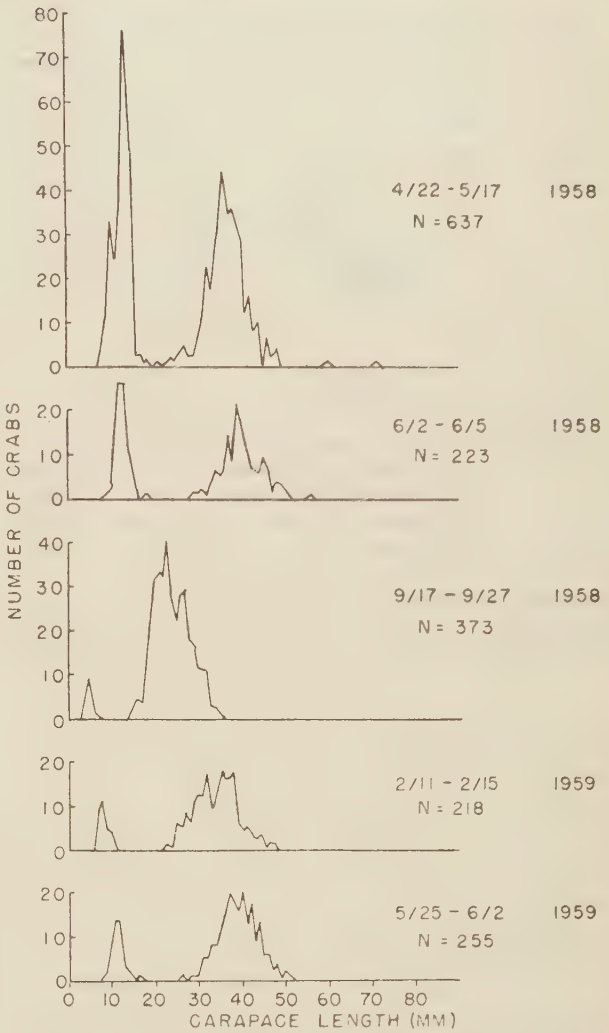


Figure 43. Size frequency distribution of juvenile king crabs taken at Unalaska in 1958 and 1959.

In general, the growth studies are progressing at an encouraging rate and although effort toward determining the growth of the intermediate sizes will be continued, some of the emphasis may be diverted toward other phases of the investigation.

As in growth studies analysis of data has been emphasized in studies on abundance, distribution, and the effect of environment. The abundance estimates of 18 and 20 million commercial size male crabs presented last year have been re-examined and we are attempting to calculate standard errors of the estimates. The estimates were calculated by expanding the density of king crabs per area fished, by the total area in the station pattern. We plan to verify these estimates by analysis of the tag recoveries. The 1957 estimate and the estimate of abundance determined from tag recoveries in the same year of 1956 tags, provide general agreement. We have recently received the Japanese catch statistics for 1958 and analysis for a similar comparison is now in progress.

Migration and degree of mixing studies have also resumed after receipt of the Japanese catch and effort data. Examination of the rates of recoveries to date indicate that the magnitude of tag releases may be insufficient to provide recoveries in adequate numbers. Realizing this, our plan during the second phase of the 1959 field work emphasized release of large numbers of tags at three or four widely separated areas.

Continued and probably increased tagging is also indicated by an examination of king crab distribution by size, sex, and shell condition. Catches during

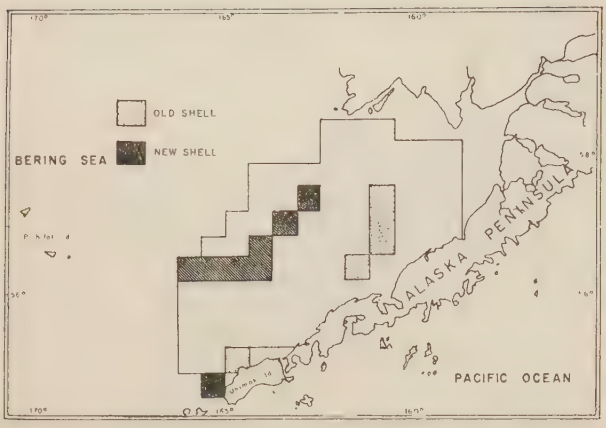


Figure 44. Areas of abundance of commercial size male king crabs by shell types as indicated by otter trawl catches in 1958 (commercial size is 135 mm. and greater in carapace length).

the station pattern sampling surveys show areas of old shell male crab abundance north of Unimak Island and in a large band centered about 56°30′N. and 160°30′W. The new shell males on the other hand exhibit a very different distribution, being found most abundantly in the western and deeper part of the station pattern (Fig. 44). Further examination shows that the distribution and abundance of mature females are highly correlated with the distribution of old shell males. Particularly high association is indicated in the spring and leads us to believe that the old shell males are the mating crabs.

In past discussions we have presented the relationship of a catch of about 1.2 to 1.5 million male crabs against an abundance estimate approximating 20 million commercial size male crabs. Since the fishery continually selects the large old shell male crabs, the numbers available in any year are substantially less and points out the necessity of examining further the relations between the new shell to the old shell mating crabs.

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